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The Objective Specification of Color

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THE measurement and specification of color has tended, in recent years, to partake more of the precision of a science and to show less of the uncertainty of an art. The pressure of competition in an economic system dependent upon mass production methods has done much to force the dyer and others in the field of color to rely more and more upon color measuring and color specifying devices. Fortunately, the development of new color measuring instruments has provided the necessary tools to fit these requirements. It is to be regretted, however, that the dyer and colorist have not taken more advantage of the assistance that the instruments provide. There is perhaps a reason for this situation which is inherent in the nature of the problem. For many generations man has been accustomed to evaluate the color of a material by purely visual methods and, although there has always been a feeling of dissatisfaction with the precision obtained by this method, very little has been done to correct this condition by the colorists themselves. The fact that colors may look entirely different under two different types of illumination is generally appreciated. Two blue samples that appear to match in daylight, for instance, may seem entirely dissimilar when compared under the artificial illumination of a tungsten lamp. A common occurrence is for one of the blues to appear to go slightly green. The fact that browns behave similarly—that is, they match when compared under some illuminations and not under others—is also a well known phenomenon to color matchers everywhere. It is generally felt that this problem could be solved if the perfect type of illumination for color matching could be obtained. It should be stated very emphatically, however, that there is no perfect illuminant in this sense. The reason for this misunderstanding lies in the fact that there has always been an attempt to simplify the problem of color measurement rather than to understand it. It has been stated often before that the eye is not an analytical instrument, but the continued attempts to utilize it for color analysis illustrate that the inferences of this simple statement have not been sufficiently understood. Most of the phenomena of color matching may be explained very simply if a few fundamental principles pertaining to the branch of physics known as optics are grasped. A color matcher realizing these principles would never attempt to match samples visually near a window which faced a red brick building and then expect these matches to be accepted by his customer who may not have enjoyed the same disadvantages of illumination. He would, in fact, understand the practical limitations of matching under any single source of illumination, but would be prepared to provide a match that will be valid under any source.

The use of instruments to measure and specify color is not, in itself, a solution of the problem. As with all instruments, they must be properly designed to meet the specific requirements of the problem and, above all, they must be intelligently used. Because of the pressing need for such instruments, many have been placed upon the market in recent years. Depending upon the skill of the designer and his understanding of the nature of the problem, these instruments may have more or less usefulness. In undertaking to use such a device, the dyer or colorist should ascertain, through the medium of publications and his trade journals, whether the instrument in question has been used sufficiently to produce unequivocal results.

Unlike the ear, the eye is unable to distinguish the various components of the stimulus that reaches it. When listening to a symphony, it is frequently possible to distinguish the various instruments used in the orchestra and it is easy, of course, to "hear" the tenor of a male quartette. That is, even though the music makes a harmonious blend, it is possible to select mentally the individual notes. When we look at the sky on an overcast day, it is impossible for us to distinguish in this light the various color components of the rainbow. This, in spite

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of the fact that it is very easy to show that all of these components are present. Years ago Newton dispersed sunlight into light of various colors by the use of a glass prism. A study of this phenomenon disclosed that the differences in color were caused merely by differences in the wavelength of light[1]. The visible spectrum, or division of white light into its colored components, is commonplace and it is generally known that each color corresponds uniquely to a wavelength number. The spectrum colors may be very broadly designated by the following wavelength numbers:

Violet	400 to 460 millimicrons[2]
Blue	460 to 500 millimicrons
Green	500 to 570 millimicrons
Yellow	570 to 590 millimicrons
Orange	590 to 610 millimicrons
Red	610 to 700 millimicrons

It should be realized that these divisions are extremely broad because the colors change continuously from one to the other throughout the spectrum. The analysis of the color of an object consists in determining the amount of light reflected (or transmitted) by this object at each wavelength of the visible spectrum. This analysis is accomplished by means of a spectrophotometer and the results are usually presented in the form of spectrophotometric curves in which the amount of light is plotted against the wavelength of the light in the visible spectrum. Two such curves are shown in Fig. 1. The usefulness of the spectrophotometric method of color analysis will be appreciated when it is understood that the color of an object seen by the normal eye under a standardized set of conditions depends only upon the spectral reflectance characteristics of the object and upon those of the light source by which it is illuminated. These characteristics are readily determined by means of a spectrophotometer and a spectroradiometer, respectively. The sensitivity of this method of analysis has been definitely shown[3] to exceed that of the human eye. Furthermore, the spectrophotometric curve of the sample completely describes its color in precise mathematical language.

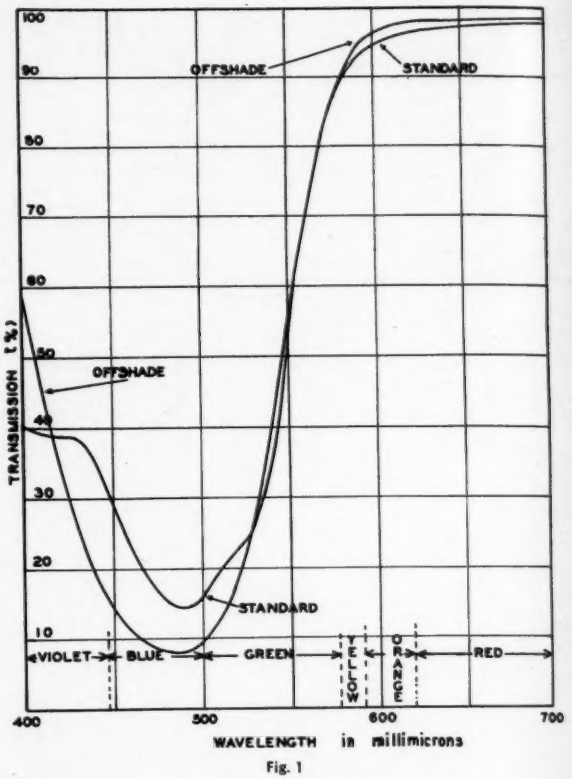

Fig. 1

This sort of specification is entirely objective and two materials having identical spectrophotometric curves will always look exactly alike under any type of illumination. A purely objective specification of this kind is not, however, entirely satisfactory to either the colorist or the psychologist because it does not convey in familiar words an evaluation of the color sensation. The most common terms used in an effort to describe this subjective sensation are brilliance, hue, and saturation, and are defined as follows:[4] "Brilliance is that attribute of any color in respect of which it may be classed as equivalent to some member of a series of grays ranging between black and white." Thus we may cause a color to appear progressively duller (or less brilliant) by the addition of black. Another illustration of this is the gradual diminution of the brilliance of a colored spotlight until the stage has been left in total darkness.

"Hue is that attribute of certain colors in respect of which they differ characteristically from the gray of the same brilliance and which permits them to be classed as red, yellow, green, or blue."

"Saturation is that attribute of all colors possessing a hue, which determines their degree of difference from a gray of the same brilliance." Thus a scarlet would be termed more saturated than the pink produced by mixing this same scarlet with neutral gray.

In an effort to approach the psychologist's subjective terminology and at the same time avoid the uncertainties

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[1]Light is propagated in a wave motion through free space with a constant velocity of approximately 186,000 miles per second. Some of these waves have a greater frequency than others and the distance between wave crests (or the wavelength) is therefore shorter. This fact may be expressed by the following equation:

$$\text{Wavelength} = \frac{\text{Velocity}}{\text{Frequency}}$$

When a beam of light composed of many wavelengths (white light) enters a wedge shaped medium, such as a glass prism, each portion of light is slowed down by an amount that depends upon the wavelength. The light is also deviated, or bent, and the amount of deviation also depends upon the wavelength. The shorter wavelengths, being bent more than the longer ones, are separated from them and the result is a separation of the original beam into its individual wavelength components. Since each of these wavelength components produces a different color sensation when seen by the eye, a colored spectrum results.

[2]25,400,000 millimicrons=1 inch.

[3]R. D. Nutting: Detection of Small Color Differences in Dyed Textiles, Am. Dyestuff Reptr. *23*, 251, May, 1934.

[4]1921 Committee Report on Colorimetry, J.O.S.A. 6, 527 (1922).

inherent in such a purely subjective designation, the physicist has evolved a set of three objective specifications. They are known as luminosity (or brightness), dominant wavelength, and purity, and they correspond to the subjective classification of brilliance, hue, and saturation as well as any cause can correspond to the effect it produces. Dominant wavelength is evaluated in units of the wavelength (the millimicron) of a monochromatic spectral color while purity and luminosity are given in per cent. These terms will be explained in more detail in the discussion that follows:

A good example of objective specification by means of the spectrophotometric curve and by the use of the three colorimetric terms based on the curve is given in the following comparison of two dyestuffs for coloring wool. The dyestuff termed "standard" had been used for some time in a routine dyeing technique. When more was required, the dyestuff manufacturer refilled the order with the dye designated here as "offshade." The dyer, being unable to match his cloth dyed with the new consignment, concluded after a complicated series of dyeings that the offshade dyestuff was either of a different concentration from the standard or that it had been "typed" with a small amount of some adulterant dyestuff.

The spectrophotometric curves, shown in Fig. 1 for solutions of equal concentrations of these dyes, are most revealing. It is seen at once that the dyestuffs were assuredly not the same and that the refill designated as offshade was a stronger, purer dye than the original standard. The irregularities in the curve of the standard would indicate that it and not the offshade had been typed with an adulterant dyestuff. While so much has been learned from a mere inspection of the spectrophotometric curves, the dyer would like to specify the differences in terms of the three colorimetric specifications. When the dyes are seen under an illumination approximating daylight in quality, the values of these terms are found to be as follows:

	Dominant[5] *Wavelength*	*Excitation*[5] *Purity*	*Brightness*
Standard	603.7 millimicrons	58.3%	58.2%
Offshade	599.0 millimicrons	73.5%	56.9%

From the table it is seen that the standard was slightly redder than the offshade, having a dominant wavelength 4.7 millimicrons greater. A comparison of the purity values shows that the offshade is considerably the stronger dyestuff, having an excitation purity 15.2 per cent greater.

This comparison of the two dyestuffs presents a good example of the need for the methods of color specification. While the spectrophotometric curves alone gave a quantitative measurement of the differences between the dyes, it is not always convenient to speak in terms of curves. It should be inferred from this that both methods of color specification have their sphere of usefulness and, to explain this relationship more clearly, the following analogy might be helpful. Let us suppose that an important long distance telephone call must be made and that the toll for

[5]Values read directly from Fig. 2, the significance of which will be explained later.

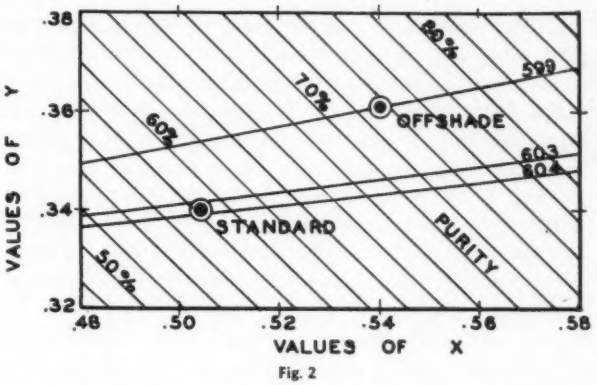

Fig. 2

this message is known to be exactly $2.00. If we are able to put the call through in the presence of an attendant, it is obvious that it is quite immaterial whether the money is in the form of a two-dollar bill or in small change. However, if the call is to be made at a pay station, it is most necessary that the requisite number of nickels, dimes, and quarters be available. The possession of a two-dollar bill would be of no use at all, despite the fact that we know that the call will cost exactly this amount. In a similar way, it is often most essential to have our color information in an analyzed form. For instance, in certain methods of three-color photography, it is important that one of the dyes have a complete absorption of red light. It is quite impossible to tell by looking at a dyed gelatine filter that it will have this property. In fact, the only description to apply to this minus red dye is that it appears to be a bluish-green. This dye could still appear a bluish-green and yet have enough transmission in the red to invalidate its use for color photography. Having the spectrophotometric curve of this particular dye, we can perform a simple mathematical operation and describe its color in terms of dominant wavelength, colorimetric purity, and brightness. However, if we possessed these three values only, it would be impossible to tell whether or not this filter completely absorbs red light. It is quite plain then that, while both methods of objective specification are useful, the spectrophotometric curve has by far the more fundamental value.

In order to understand how the descriptive values given in the preceding table were obtained from the spectrophotometric curves and a knowledge of the type of illuminant used, the following explanation may be found helpful. As a result of extensive experiments carried on over a period of more than 100 years, it is known that any color may be matched visually by the use of three suitable stimuli mixed additively in proper proportions. For the sake of convenience, these stimuli may be considered to be three colored lights—say, for instance, a blue light, a green light, and a red light. If these lights were produced by dispersing white light into a colored spectrum and selecting only a narrow band in each of the three spectral regions having the colors mentioned, they would be referred to as monochromatic stimuli. They might be produced by placing colored filters in front of a tungsten

bulb, and in this case they would be referred to as heterogeneous stimuli. For the solution of the problem at hand, it is entirely immaterial what primaries are selected, provided that no two of them will combine to produce the third. We may therefore choose a set of primary stimuli in such a way that their addition in equal amounts will produce white and proceed to match each color (i.e., each wavelength of monochromatic light) of the visible spectrum by means of suitable combinations of the three stimuli. The amount of each of these three stimuli plotted against the wavelength of the light they are combined to match throughout the visible spectrum gives a set of three curves, one for each stimulus. In the report of the 1931 International Commission on Illumination Standard Observer and Coordinate System for Colorimetry[6], the three curves representing the average of seventeen different observers was obtained. However, the original set of curves was found to be inconvenient to use and, by a simple mathematical procedure, they were transformed into a more usable form. In the I.C.I. report these curves, shown in Fig. 3, have been so arranged that no values are negative and that one of the curves—namely the $\bar{y}$—corresponds to the visibility function of the normal eye. The integrated areas under each of these curves, which are referred to in the I.C.I. report as distribution coefficients, have been maintained equal so that mixing these three stimuli still produces white (of an equal energy spectrum).

Having obtained a function for the normal eye in terms of the wavelength of light of the visible spectrum, we are now in a position to translate the spectrophotometric analysis of a colored material and its illuminator into terms of color as seen by the eye. For convenience of mathematical consideration, we will measure the amounts of each of the three stimuli at every wavelength throughout the visible spectrum and plot the values of $\bar{x}$, $\bar{y}$, and $\bar{z}$ against the wavelength as shown in Fig. 3. At any one wavelength, there will be three values, one for each stimulus. We now obtain the fractional value for each stimulus at each wavelength. To illustrate this step, refer again to Fig. 3. At a wavelength of 475 millimicrons, for example, the values of the distribution coefficients are:

$$\bar{x} = .1421$$
$$\bar{y} = .1126$$
$$\bar{z} = 1.0419$$
$$\bar{x} + \bar{y} + \bar{z} = 1.2966$$

and from these coefficients the following fractional values may be calculated:

$$x = .1421/1.2966 = 0.1096$$
$$y = .1126/1.2966 = 0.0868$$
$$z = 1.0419/1.2966 = 0.8036$$
$$x + y + z = 1.0000$$

These fractional values are referred to in the I.C.I. report as the trichromatic coefficients. Since the sum of any three coefficients for one wavelength is always equal to 1, it is found convenient to plot one of these coefficients against one of the other two. It is customary, merely as a convention, to plot the y coefficient against the x. A diagram made in this manner is generally known as a Maxwell color mixture diagram and any point on the resulting curve represents the locus of a spectrum stimulus. In other words, any point on this spectrum locus curve shown in Fig. 4 corresponds to a pure spectral color, while the point represented by x = .3101, y = .3163 corresponds to the color of average daylight (I.C.I. Illuminant C).

Just as it has been found that any color may be matched by the proper admixture of three arbitrary stimuli, it is

[6]D. B. Judd, J. Op. Soc. A. *23*, 359 (1933).

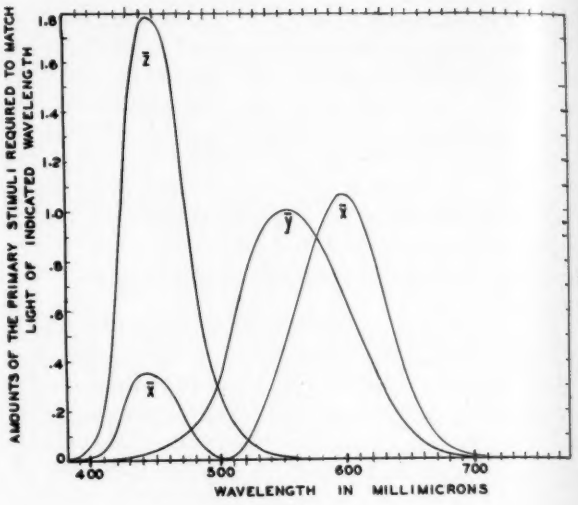

Fig. 3

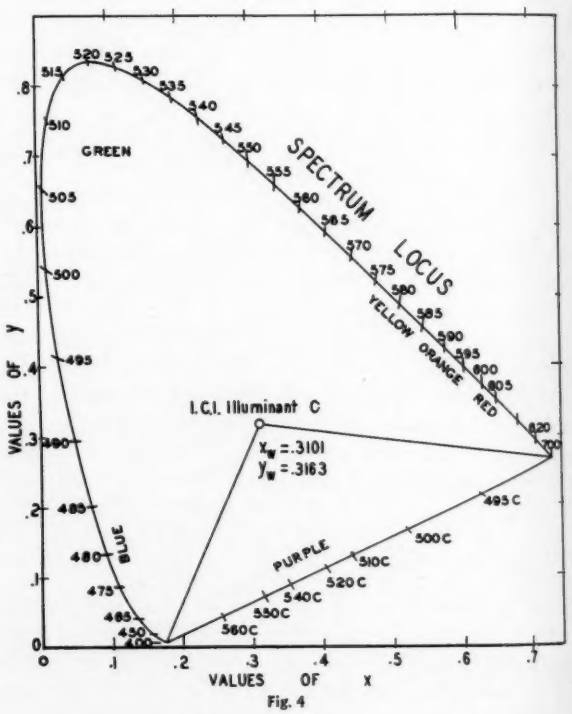

Fig. 4

also found that any color, except purple, may be suitably matched by a mixture of white light and some pure spectral color. It is at once seen that this is no contradiction to the previous concept for now, instead of having three heterogeneous stimuli, we have at least one homogeneous stimulus (the pure spectral color) and two other stimuli which must be added to the homogeneous stimulus to compose the color of average daylight. Since we are going to specify our colors in terms of a mixture of some monochromatic light of a certain wavelength (called dominant wavelength) and white light, it seemed essential to establish the connection between this definition of color and one involving only the trichromatic coefficients.

The purity of a color is that percentage of the dominant wavelength found in the mixture that produces the desired color. These two values, dominant wavelength and purity, correspond to the more descriptive terms, hue and saturation. It will now be necessary to go somewhat more thoroughly into the mathematics of our color specification and we will then discover what is meant by brightness (luminosity) which corresponds to the psychological term of brilliance.

Since the eye is not an analytical instrument, it is impossible to look at a color and describe the relative amounts of light reflected from it in each portion of the spectrum. It is perfectly obvious then that the eye performs an integration: that is, it sums up the light received from the source of illumination modified by the spectral reflection (or transmission) characteristics of the colored object, for all wavelengths in the visible spectrum and presents its summation to the brain in the form of a color. The source of illumination for the present has been taken to be I.C.I. Illuminant C which is a close approximation of average daylight. Through our distribution coefficients, we are now able to perform the integrating (or summing up) function of the eye mathematically and we may express these functions, as visualized through our tri-stimulus specifications, by the following three integrals:

$$\int_{400}^{700} \bar{x} E_c R d\lambda; \qquad \int_{400}^{700} \bar{y} E_c R d\lambda; \qquad \int_{400}^{700} \bar{z} E_c R d\lambda$$

where $\bar{x}$, $\bar{y}$, $\bar{z}$, E, and R are all functions of λ, the wavelength of light in the visible spectrum. $\bar{x}$, $\bar{y}$, and $\bar{z}$ are the distribution coefficients and represent the three functions of the eye, E_c is the energy distribution of the illuminant and R is the spectral reflectance (or transmission) of the sample to be examined, each taken wavelength by wavelength throughout the spectrum. Since it is usually difficult to represent spectrophotometric curves by a convenient mathematical function and the same is true for the coefficients and the energy distribution of real light sources, it is necessary to perform a graphical integration. These three functions now take the following forms:

$$\sum_{400}^{700} \bar{x} E_c R \Delta\lambda; \qquad \sum_{400}^{700} \bar{y} E_c R \Delta\lambda; \qquad \sum_{400}^{700} \bar{z} E_c R \Delta\lambda$$

The expression $\sum_{400}^{700} \bar{x} E_c R \Delta\lambda$ is a mathematical convention signifying that the values, $\bar{x}$, E_c, and R are to be multiplied together at each small interval of wavelength ($\Delta\lambda$) throughout the visible spectrum (from 400 to 700 millimicrons) and that all of these multiplied values will then be summed. The brightness, or luminosity, may be defined as:

$$\% \text{ Brightness} = (100) \frac{\sum_{400}^{700} \bar{y} E_c R \Delta\lambda}{\sum_{400}^{700} \bar{y} E_c \Delta\lambda}$$

It was stated in the previous explanation that all colors except purple may be matched by a suitable mixture of white light and some spectral color. Purple is matched by subtracting from the white light a suitable spectral color, which usually lies in the green region of the spectrum. This subtraction is accomplished in practice by adding the green to the color to be matched until it is identical with the illuminant (in this case, I.C.I. Illuminant C). Thus purples are reported as having their dominant wavelengths in terms of complementary colors, denoted on the color diagram by the suffix C.

Having described the way in which the integration performed by the eye to produce color sensations in the brain can be performed mathematically, it now remains to illustrate this method by examples and to give some applications. The first step in the objective specification of the color of an object is to obtain its spectrophotometric curve as a function of the wavelength of light in the visible spectrum. It now follows from the equations given previously that this function must be multiplied by the energy of illumination and by each of the three visibility functions at each wavelength of the visible spectrum. The values of these three products derived from integrating these functions throughout the visible spectrum are now added together and their fractional values, represented as x, y, and z, are called trichromatic coefficients. The sum of x, y, and z is always equal to 1. The derivation of the trichromatic coefficients for the three chosen stimuli which represent the function of the average normal eye was described in an earlier section of this discussion and, at the same time, the manner in which the color diagram is constructed was given. It will be recalled that this diagram was made by plotting y against x. Place the x, y values obtained from our recent integration on the color diagram and connect this point by a line passing through the $x_w y_w$ values of illumination (in this case I.C.I. Illuminant C, $x_w = .3101$, $y_w = .3163$). A projection of this line intersects the curve representing the locus of spectral colors at some point that we will designate as X,Y. The value of this intersection in millimicrons read directly from the spectrum locus curve gives us the dominant wavelength of our colored substance under the specified illumination. The distance of the point designated by x, y from the source of illumination to the spectral locus gives the excitation purity of the color under consideration. The

calculation of purity is given by the following formula:

$$p = \frac{(y-y_w)}{(Y-y_w)}$$

Fig. 5 shows the color diagram with a few lines drawn from the Illuminant C ($x_w = .3101$, $y_w = .3163$) to the spectrum locus. These lines radiating from the center of the diagram are designated by the proper wavelength number. The method for designating the wavelength of purple colors is illustrated by the continuous line drawn from 495 millimicrons on the spectrum locus through $x_w y_w$ and extended to the point marked 495C. All colors lying on this line between x_w, y_w and 495C are purples. Similarly, other hues of purple will fall on one of the other complementary wavelength lines designated by the suffix C. The computation of excitation purity has been facilitated by drawing lines of constant purity on the diagram. Thus, from the enlarged section of the color diagram, shown in Fig. 2, the values of purity and dominant wavelength may be read directly from the plot.

It was shown previously that it is impossible to integrate the functions from which the trichromatic coefficients are derived directly and Judd[7] has given specific examples of the summation of the products at each 10 millimicron interval. He has given convenient tables for $\bar{x}E$, $\bar{y}E$, $\bar{z}E$, where E corresponds to any one of three standard illuminants. I.C.I. Illuminant A is a gas filled lamp of color temperature 2848° K and corresponds to an incandescent tungsten lamp. Illuminant B is an approximate representation of noon sunlight and Illuminant C is an approximate representation of average daylight. The energy distribution of Illuminant C is shown in Fig. 6. This is produced by placing two special colored solutions in front of an incandescent lamp operating at 2848° K.[8] As might well be imagined, this summation is exceedingly tedious and, in order to facilitate a rapid computation of the necessary x, y, and z values, a method has been adapted by Hardy[9] which is termed, in view of its mechanism, the method of selected ordinates. The values of the products $\bar{x}E$, $\bar{y}E$, and $\bar{z}E$ may be plotted against the wavelength (λ) The area under the $\bar{y}E$ curve is represented by the integral $\int_{400}^{700} \bar{y}E d\lambda$ and may be divided into any convenient number of small areas. Each of these areas is represented graphically by a line bisecting the small area and parallel to the $\bar{y}E$ axis. In Fig. 7, $\bar{y}E_c$ (Illuminant C) has been plotted against wavelength and the area under the curve has been divided into ten equal areas. The full vertical lines designate equal areas and the dotted vertical lines refer to the average value of each small area and are the selected ordinates. These dotted lines may be engraved

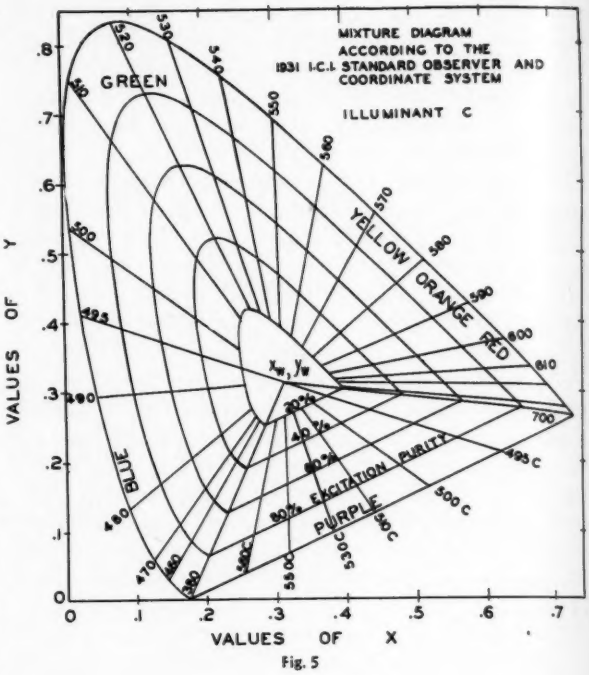

Fig. 5

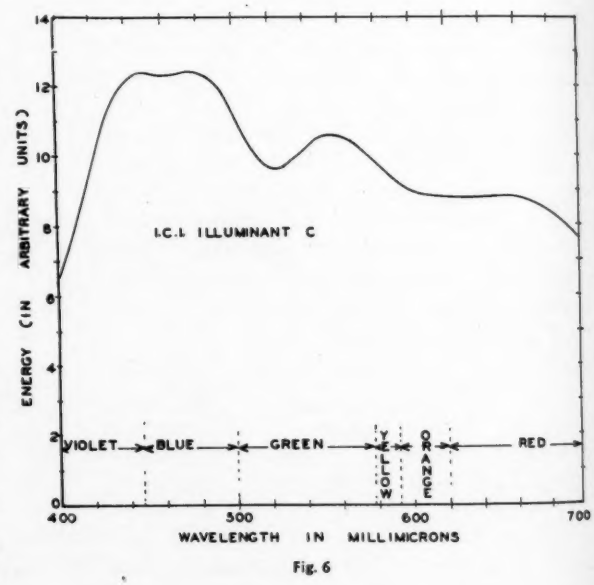

Fig. 6

upon a glass plate, which is made to the same scale as that used in constructing the spectrophotometric curves. For any one type of illumination three plates are necessary, one for the $\bar{x}E$, one for the $\bar{y}E$, and one for the $\bar{z}E$ function. One of these plates is now placed upon the spectrophotometric curve and the values of reflectance (or transmission) at which the selected ordinates intersect the curve are read off. Since each line represents an equal area, it should be obvious that the addition of these ordinates represents the summation $\sum_{400}^{700} \bar{y}E_c R \Delta\lambda$, etc. The plates used

[7] D. B. Judd: loc. cit. (c.f. pg. 586 of this paper).
[8] R. Davis and K. S. Gibson: "Filters for the Reproduction of Sunlight and Daylight and the Determination of Color Temperature"—Bur. Std. Misc. Pub. No. 114, Jan. 1931.
[9] A. C. Hardy and O. W. Pineo: "The Computation of Trichromatic Excitation Values by the Selected Ordinate Method"—paper presented before the Optical Society of America at Cambridge, Mass., Feb. 1932.

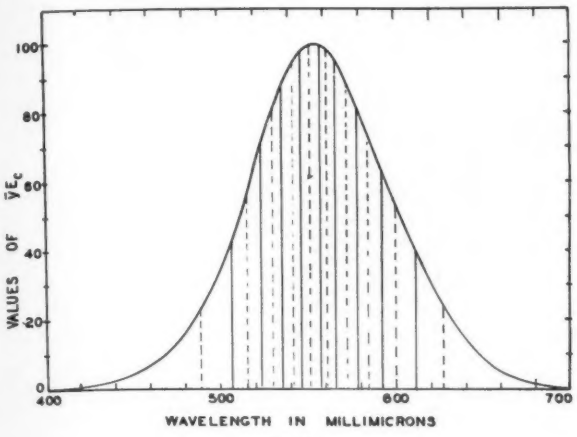

Fig. 7

here were so arranged that either 10 or 30 selected ordinates may be used, depending upon the complexity of the spectrophotometric curve to be integrated.

The integration of the spectrophotometric curves representing the "standard" and "offshade" dyestuffs previously described in Fig. 1 is given in Table I.

TABLE I

No. of Selected Ordinate	*Standard* $\bar{x}E_cR$	*Standard* $\bar{y}E_cR$	*Standard* $\bar{z}E_cR$	*Offshade* $\bar{x}E_cR$	*Offshade* $\bar{y}E_cR$	*Offshade* $\bar{z}E_cR$
1	35.0	9.4	38.8	22.0	8.1	33.0
2	22.5	21.0	38.2	10.8	15.0	25.0
3	40.0	25.5	36.0	46.0	26.7	20.3
4	73.5	36.0	33.0	73.5	41.5	17.2
5	86.5	55.0	29.0	86.6	58.0	14.5
6	91.5	71.0	25.5	96.0	51.0	12.3
7	94.0	83.0	22.5	97.0	83.2	10.8
8	95.5	90.5	19.4	98.0	91.0	9.3
9	96.4	94.4	15.0	98.0	96.0	8.2
10	97.0	96.5	14.6	93.0	98.0	8.5
Total*	731.9	582.3	272.0	720.9	568.5	159.1

*Total = $\sum\bar{x}E_cR\Delta\lambda$, $\sum\bar{y}E_cR\Delta\lambda$ or $\sum\bar{z}E_cR\Delta\lambda$

1.1812 ($\sum\bar{x}E_cR\Delta\lambda$) = 865.0 ..... **852.0**

0.9804 ($\sum\bar{z}E_cR\Delta\lambda$) = 266.8 ..... 156.0

	Standard	*Offshade*
($\sum\bar{x}E_cR\Delta\lambda + \sum\bar{y}E_cR\Delta\lambda + \sum\bar{z}E_cR\Delta\lambda$) =	1714.1	1576.5

$$x = \frac{865.0}{1714.1} = 0.505 \qquad \frac{852.0}{1576.5} = 0.541$$

$$y = \frac{582.3}{1714.1} = 0.340 \qquad \frac{568.5}{1576.5} = 0.361$$

$$z = \frac{266.8}{1714.1} = 0.155 \qquad \frac{156.0}{1576.5} = 0.098$$

$$x + y + z = 1.000 \qquad 1.000$$

$$\frac{\sum\bar{y}E_cR\Delta\lambda}{\sum\bar{y}E_c\Delta\lambda} = \frac{582.3}{1000} = 58.23 \qquad \frac{568.5}{1000} = 56.85$$

Only ten selected ordinates are used in order to simplify the computation. It is generally advisable to use the thirty selected ordinates for more precise work. $\sum\bar{x}E_cR\Delta\lambda$ and $\sum\bar{z}E_cR\Delta\lambda$ must be multiplied by a factor in order to adjust these values for the trichromatic coordinates of the white point. By this is meant simply that if R were to be 1 (for a perfect white), the summations under Illuminant C would yield x = .3101 and y = .3163, which is obviously the location on the color diagram of Illuminant C. This would, of course, not be a perfect white but is slightly blue in color so, in order to correct all of the integrated values, it is necessary to multiply $\sum\bar{x}E_cR\Delta\lambda$ by 1.1812 and $\sum\bar{z}E_cR\Delta\lambda$ by 0.9804 for Illuminant C. For other illuminants, other multiplying factors must be used. The values of x and y obtained here were placed on the color diagram and an enlarged section is shown in Fig. 2. This chart along with the specification of brightness may now be used to uniquely designate the "standard" and "offshade" dyestuffs when seen under Illuminant C.

This method of color specification, while not so satisfactory as a complete spectrophotometric curve, is very useful in showing tolerance limits. It is seldom that a machinist will be told to duplicate a piece of work without also being told what tolerance limits are required. Why, then, should we expect colors to be matched "exactly"? It will be shown in a future paper that colors are seldom matched exactly but are matched within certain small limits of tolerance. In specifying what tolerance limits are required, the use of charts such as presented here should be very helpful. It is now possible to designate in definite units of color what the limits of a match shall be just as it is possible to say that the clearance on a drilling shall be within 1/64 of an inch.

While the spectrophotometric curve is of such comprehensive value in the measurement and specification of color, if tolerance is the only concern of the dyer, he may determine it by other methods. A colorimeter, which is an instrument designed to measure the amount of light reflected (or transmitted) by the sample through three colored filters, may be used for this purpose. It is fundamental for the proper use of such a device that the three filters be measured spectrophotometrically and the source of illumination measured with a spectroradiometer in order to determine the energy distribution curves. When these are known, it is then possible to translate these results by mathematical transformation into the universal terminology of the I.C.I. Standard Observer and Coordinate System. A very thorough report on the use of the colorimeter has been given by Guild[10] and his paper should be consulted by all persons interested in using this method of color specification. The disk colorimeter[11] may also be used to specify color tolerances on the color diagram if

[10] J. Guild: "The Instrumental Side of Colorimetry," J. Sci. Instruments II, 69, March 1934.

the spectrophotometric measurement of the colors used on the disk has been first made. Lovibond glasses[12] provide another method of accomplishing the same result and here, again, it is first necessary to have a knowledge of the spectral transmission of the glasses used.

Some instruments on the market have attempted to effect a compromise between the spectrophotometer and the colorimeter by using as many as seven separate filters through which to measure the reflectance of the colored samples. Generally, it is found that the transmission characteristics of these filters are far from monochromatic and that no attempt has been made to correlate the readings with any universally standard system of colorimetry. It should be realized that each of these filters covers a rather broad spectral region and the readings can be shown experimentally to present an entirely different spectral analysis from the actual spectrophotometric curve.

CONCLUSION

A method has been presented by which the spectrophotometric analysis of a colored object may be translated into a set of three numbers which uniquely describe the color of the object under the conditions of observation. These numbers are based only upon the characteristics of the normal human eye, the spectral reflectance characteristics of the colored object, and the spectral distribution of the light source by which the object is illuminated. Two of these quantities are entirely physical in nature and are measured in the fundamental units of the wavelength of light and of energy. The factor of the human observer was determined by carefully taking the average of numerous persons, all possessing normal vision. It is felt, therefore, that the terms, dominant wavelengths, excitation purity, and brightness, offer an unambiguous definition of the color of an object under a set of specified conditions of observation. It is hoped that this fundamental terminology will be used by dyers and colorists to their advantage in describing colors and in expressing color tolerances.

ACKNOWLEDGEMENT

The author wishes to express his appreciation for the advice and assistance so generously given by Professor Arthur C. Hardy in the preparation of this paper.

[11]D. Nickerson: "A Method for Determining the Color of Agricultural Products," U. S. Dept. of Agriculture Tech. Bull. No. 154, 1929.

[12]G. S. Fawcett: "Color Measurement," Chem. & Ind. p. 1005 (1933).

● TEXAS TECHNOLOGICAL COLLEGE

M. E. Heard, who has been in the textile engineering department at Texas Technological College for seven years, has been promoted to acting head of the department upon the resignation of C. D. Brandt. R. F. Redding, who has been with the Lanette Bleachery & Dye Works of Lanette, Ala., will take the place of assistant professor of textile engineering and teach weaving and design. Redding and Heard are both graduates of Georgia Tech.

Professor Heard says the textile department is trying to create more interest in the development in Texas of textile manufacturing not only in cotton but in wool and mohair. Value of textile machinery available for students here is $100,000. Three options are offered textile students, textile engineering, chemistry and dyeing, and weaving and design.

● GENERAL RELEASES

General Dyestuff Corp. announces release of bulletins on the following products. Copies of the bulletins are available upon request.

Diazo Sky Blue BA—which is said to produce particularly bright shades of reddish blue when diazotized and developed with beta naphtol. It is stated that these shades possess good fastness to washing and excellent dischargeability.

Naphtol AS Dyeings and Prints of Vat Color Fastness—a sample card showing all Naphtol AS combinations, Rapid Fast, Rapidogen and Rapidazol dyestuffs which have standard all around properties. The fastness properties to light, chlorine and hot pressing as well as the dischargeability are indicated by symbols which are explained in the booklet.

● ANNUAL MEETING, U.S.I.T.R.

In order to have as its guest and principal speaker Dr. Robert A. Millikan, eminent scientist of California Institute of Technology, the annual meeting of U. S. Institute for Textile Research, Inc., will be postponed from Nov. 7 to Thursday, Nov. 14, but will be held as originally planned at the Waldorf-Astoria, New York, N. Y. Adequately to celebrate the end of its fifth year, and to honor its guest, Dr. Millikan, U. S. Institute will give a dinner that evening in the hotel's Astor Gallery at which President Francis P. Garvan, who is also president of the Chemical Foundation, will act as toastmaster. While the subject of Dr. Millikan's address has not been announced, his reputation as a scientist and speaker should attract a record-breaking attendance.

Another notable feature of the dinner will be reports of several actual applications of scientific textile research in the mills by technicians responsible for them. Dr. J. R. Katz, director of U. S. Institute's warp sizing research, now in progress at Massachusetts Institute of Technology, will also speak.

The regular annual meeting and meetings of the board of directors will be held in the morning, starting at 10 o'clock. In the afternoon U. S. Institute's Research Council will hold an open conference on the subject of creping of regenerated rayon and acetate fabrics, to which all who are interested are cordially invited. The committee in charge of the latter conference is Dr. H. DeW. Smith, vice-chairman of U. S. Institute's Research Council, chairman, H. E. Bishop, executive secretary, Throwsters Research Institute, and C. H. Clark.

The Committee on Meeting is William W. Buffum, treasurer and general manager of the Chemical Foundation, chairman, Dr. H. DeW. Smith and C. H. Clark.

Power and Heat Problems

in Dyeworks and Bleacheries

By C. H. S. TUPHOLME

IT WOULD not be unfair to say that of the time and energy devoted to technical matters by the superintendent of a dyeworks or bleachery, at least 95 per cent is concerned with problems of a purely chemical nature. Yet one of the vital factors in such works is a cheap, constant and reliable source of heat, and this factor can have a most startling influence on both the quality and the economy of the plant operation.

All plants requiring boilers under steam for purposes other than the generation of power, have a supply of energy available which they cannot profitably continue to overlook, as the power derivable therefrom is only a by-product of the steam already being generated, and costs practically nothing beyond capital charges. If any manufacturing process necessitates the production of a reasonable quantity of steam all the year round, then the cheapest possible public supply of electricity will never equal in reduced costs that immediately available to the user.

Super central stations are only able to utilize approximately 20 tons of every 100 tons of fuel burned, the remainder (80 per cent) being rejected and entirely lost, while probably in an industry utilizing steam for manufacturing purposes it will be possible to arrange the plant, both steam and power, so as to be able to utilize effectively from 50 to 60 tons of every 100 tons of coal now burnt under the boilers. If this is so, need it be repeated that the larger super station with a thermal efficiency of only 20 per cent can never hope to offer a tariff that would be attractive when a private plant can be operated at an efficiency as high as 50 to 60 per cent.

While it is acknowledged that the modern high pressure boiler will operate at 80 per cent efficiency over long periods, yet the fact remains that after the steam has given up its mechanical energy, it still contains 60 per cent of the original heat, and this is rejected through the condensers, to the river or cooling towers. As long as 80 per cent of the coal burned is dissipated for no useful purpose, it is unreasonable to anticipate that the selling price of electric current will ever interest the manufacturer who has an opportunity to employ this heat usefully in some part of his processing. The secret of the economy lies in the fact that the heat which is lost by the power station in the cooling water can be usefully employed by the manufacturer in his process after extracting the energy for the production of power. Of the total heat produced by the boilers the amount utilized for producing power, as the steam passes through the turbine, and the amount leaving the turbine which is used for process work, can be adjusted in any reasonable proportion, i.e., the conversion of pressure into power is simply a by-product of the raising of steam for process purposes.

A steam table shows that while the temperature of high pressure steam is much greater than when at low pressure, yet the actual amount of heat per pound is practically the same, and consequently it is of little or no advantage to use high pressure steam for, say, boiling purposes in dyeworks, and, providing that the pipe area is sufficient to pass the same quantity at the lower velocity due to the lower pressure, then one will attain the same result in the same time. Increasing the pipe area in existing installations may be a difficult matter, but for new works, arrangements can be made for this condition, and as the amount of power that can be obtained from a given amount of steam depends upon the difference in the initial and exhaust pressures, it will be seen that, if as much power as possible is to be obtained, then it will pay to give this matter very serious consideration.

Table I indicates the approximate amount of power that can be extracted with reciprocating engines for every 10,000 pounds of steam per hour:—

TABLE I.

Boiler Pressure	*Exhaust Pressure*	*H.P. Available*
80	5	270
80	10	230
80	15	200
100	10	270
100	20	220
100	30	170
150	10	370
150	20	300
150	30	245
150	40	200
150	50	170
150	60	140
200	10	410
200	25	330
200	50	230
200	80	150

One large Lancashire type of boiler will evaporate some 10,000 pounds of water per hour, consequently generating at 200 pounds pressure, if only 10 pounds pressure is required to convey the amount of heat through the pipes

necessary to complete the "process" in a given time, one can at the same time, and practically for the same cost, generate over 400 H.P. for each hour. Low process pressures are not essential to enable these economies to be effected, as if it is necessary to pass the output of the boiler to process at, say, 50 pounds pressure, it is still possible to extract 230 B.H.P. from this amount of steam, but the extra pressure has reduced the power by 170 H.P.

The system usually employed, which enables full advantage to be taken of the properties of the steam, is known as the "back-pressure system," in which an engine or turbine is used as a reducing valve. Steam is generated at a reasonably high pressure, passed through the engine, and exhausted into the process main at any pressure required in the works. Very common back-pressures run up to 60 pounds per square inch, although there is no limit to this secondary pressure, providing always that the initial pressure is considerably higher than that at which it is wished to exhaust.

It will easily be seen that the same amount of steam must pass out of the engine as is originally admitted, less a minute quantity lost by radiation, etc., and consequently the engine, as previously stated, simply acts as a reducing valve, and generates considerable quantities of energy in so doing. Engines have occasionally been built to exhaust at pressures exceeding 300 pounds per square inch, while turbines have been supplied to exhaust at 200 pounds per square inch.

The first objection usually raised when the use of so-called exhaust steam is mentioned, is that it is contaminated with lubricating oil, but this is not so, as if the "process steam" is in direct contact with liquors, then some designers are prepared to run their engines without cylinder lubrication, providing that the steam is not superheated. These designers have constructed many engines that have been in service for many years, that have never had any cylinder lubrication whatever. Occasionally, when some form of lubrication is thought to be desirable, but oil objected to, a form of lubricant consisting of deflocculated graphite in water has been used. This has always given complete satisfaction.

This question of contaminated steam does not occur when the power requirements are such as to justify the use of turbines, as, due to the entire absence of rubbing surfaces within the steam spaces, no lubrication is necessary. The turbine lends itself also to overcoming easily the condition when the demand for power is much in excess of the steam demands, or where the two requirements do not synchronize. In this case the use of a "pass-out" turbine is advocated, in which the steam is allowed to perform a portion of its work, and when reduced to the requisite pressure for the process is passed out in sufficient quantities to maintain the supply to the works, the remainder being used through the last stages of the turbine, producing the maximum amount of power before being exhausted into the condenser. Such a plant allows of the maximum efficiency being obtained from conditions which prevent the whole of the latent heat being recovered.

In certain cases it may be found more convenient to use, in place of a pass-out turbine, a combination of back-pressure and condensing turbines, so arranged that the back-pressure turbine takes the load which can be generated from the steam required for process, and if the demand for electrical power exceeds the amount thus obtainable, the excess is automatically thrown over on to the condensing unit.

Still another alternative which has been used with great success is the running of back-pressure turbines in conjunction with public supply, automatically arranged in the same way as described above, namely, so that any excess power is automatically taken from the town mains in the event of the demand exceeding that which can be generated by the process steam. In this case the town supply acts virtually as a condensing turbine, or the condensing end of a pass-out turbine.

For comparatively small outputs extraction steam engines are sometimes used, but this type of prime mover is not advocated for pass-out conditions on account of the fact that the load is very unequally distributed between the two lines of motion under certain conditions of pass-out demand. Where this is large, the greater proportion of the power would be taken from the H.P. line, whereas if the demand falls off to nothing, the load on the L.P. line will be greatly increased and may considerably exceed that on the H.P. which is not conducive to smooth running.

If the efficiency of a "combined" plant is to be made as high as possible, then care must be taken to balance the usual fluctuations between the process and the power demands, otherwise there will be times when steam at high pressure will be exhausted to the atmosphere or condenser, with a considerable loss, while the reverse is also possible, i.e., the power plant will supply insufficient steam to the process main.

Dye and bleach works require great quantities of steam and can consume all the exhaust available, and in these cases the amount required in excess of the exhaust is fed into the main, direct from the boilers, through an automatic relay type of make-up valve, which ensures a constant pressure, irrespective of fluctuations either in demand or supply from the power plant.

Some plants, however, present greater difficulties, due to the fact that while power is required throughout the working day, the steam demand is only occasional and varying; in such cases it is often advisable to install an engine with a maximum output equivalent to the minimum demand for steam, but obviously this does not produce the maximum economy, and frequently simple arrangements are possible which allow of all the power required being produced by back-pressure engines, the surplus heat being stored against future requirements. This is especially simple in those cases where large quantities of hot water are required. Steam is fed into the main direct from the engines, and regulated as previously described.

(Continued on page 602)

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Proceedings of the American Association of Textile Chemists and Colorists

UNEMPLOYMENT REGISTER

Members of this association, who are without employment, should forward to the secretary a statement as to their qualifications and experience. This information will subsequently appear on these pages with an identifying key number. Employers are also requested to file with the secretary any vacancies which may occur in their businesses.—H. C. Chapin, Secretary, Lowell Institute, Lowell, Mass.

Key: A—Laboratory and research; B—Dyeing or printing; C—Finishing; D—Sales; E—Instruction; F—Executive.

Note: Persons who have obtained employment should notify the secretary at once. Prospective employers may file vacancies either with the secretary or the American Dyestuff Reporter.

A-3

Education—Ph.B., Brown University, 1920. Two years post-graduate work at M.I.T.

Experience—2 years instructor at M.I.T. 2 years as research chemist in print works (Gum thickenings, application of dyes, dye testing and evaluation. 4 years as chief chemist in bleaching, mercerizing, dyeing and finishing plant. 4½ years as research and plant chemist in silk mills (Colorimetric work in color matching, dye testing and identification and testing of chemicals). 2 years as organic research chemist (laboratory and semi-plant research on organic chemicals, intermediates and dyestuffs). Age 35, married. Will go anywhere, references.

A-6

Education—Analytical Chemistry and Dyeing Course, Lowell Textile Evening School.

Experience—Seven years as print color and dye chemist in printing, dyeing and finishing plants; recently in charge of textile printing department of dyestuff manufacturer.

A-B-2

Education—Lowell Evening Textile School, 1917.

Experience—Five years' experience in hosiery dyeing, full fashioned hosiery of silk and cotton and silk, also men's hosiery containing rayon, wool, cotton and celanese. Several years experience in laboratory work. Has also had experience in jig-dyeing of cotton piece goods, slub and top dyeing.

A-B-4

Education—B.T.C. 1934, Lowell Textile Institute.

Experience—Assistant chemist in cotton knitting plant; second-hand in woolen knit goods dye house. Will go anywhere; references.

A-B-5

Education—Graduate of the University of Lausanne, Switzerland. Doctor's degree in Chemistry. Knowledge of French and German.

Experience—Eleven years with large bleaching, dyeing, printing and finishing plant as assistant Chemist and then Chemist in charge of the Laboratory. Experience in dyeing and printing cotton and rayon fabrics; research and analytical work. Woman.

A-B-6

Education—B.S. in chemistry, Cooper Institute.

Experience—Seven and one-half years in application laboratories of large dyestuff manufacturer. One year as plant chemist in dyehouse and print shop. Seven years as chief printing colorist on silk, rayon and cotton. 33 years old; married; will go anywhere; references.

A-B-C-2

Education—Graduate of Lewis Institute of Engineering of Chicago and graduate of Philadelphia Textile School (Chemistry and Dyeing department).

Experience—Has had extensive experience as assistant chemist and colorist in silk printing, dyeing and finishing; also dyeing raw stock wool; and dyeing and finishing cotton and rayon. Age 30; married; references.

A-B-C-3

Education—3 years at Brown University and Drexel Institute.

Experience—2½ years in dyestuff laboratory; 3 years as second-hand, dyeing indanthrene and direct colors on rayon skeins; 6 months as boss dyer on silk and cotton ribbons and hosiery; 3 years overseer of dyeing and finishing rayon tubing. Can handle laboratory, dyehouse, finishing or outside service. Age 30; married.

A-B-C-4

Education—Graduate, University of Michigan, in Chemical Engineering, 1930.

Experience—One year as assistant chemist and research engineer with metallic packing concern. Three years' experience dyeing and finishing rayon tubing, last two years being foreman dyer. Familiar with other kinds of dyeing. Working knowledge of Spanish. Age 28. Married. References.

A-B-D-E-F-1

Education—Ph.D. in Chemistry, Pennsylvania, 1927. Graduate Work in Chemical Engineering, M.I.T., 1918.

Experience—5 years college teaching, 11 years industrial development and consulting work in diversified fields relating to textiles. Successful organizer and director of development and research. Married. Publications. Position must have opportunity for advancement.

A-C-1

Education—4 years at Newark Evening Technical School in Chemical Engineering.

Experience—8 years in manufacturing, research, testing of soaps, oils, gums and finishes and application of same in all phases of the textile industry. Age 23, single. References.

A-E-1

Education—Ph.D., Univ. of Illinois, studied chemical engineering at Columbia, licensed chemical engineer, New Jersey.

Experience—10 years' experience teaching in colleges, subjects included chemical and textile subjects. Has had broad experience in industrial work including experience in testing materials, research and consulting. Will go anywhere; references.

B-1

Education—Educated and trained in chemistry and calico printing in Glasgow, Scotland.

Experience—Has been with large print works as colorist for 13 years producing first class work on cotton, rayon, wool and silk fabrics. References.

B-2

Experience—Boss dyer with one firm for 18 years, divisional supt. at print works for 1 year, in charge of processing and dyeing of cottons and rayons at large bleachery for 6 years. Prefers bleachery in East but will go anywhere. References.

B-3

Experience—Foreman piece dyer for the past 21 years. Can dye the following: celanese, rayon, cotton backs, wool, silk and mixed fabrics. Has knowledge of finishing and laboratory work.

B-6

Education—Graduate R. I. School of Design.

Experience—5 years in bleachery, 7½ years as assistant dyer, 2 years as boss dyer and 3 years as superintendent of dyeing and finishing. Married, 33 years old. References.

B-7

Experience—Eight years as boss dyer on skeins and ribbons. Over ten years as chemist and head dyer for a large hosiery mill. Experienced on Silk, cotton, rayon and wool in skeins, ribbons, piece goods and all kinds of mixtures. Willing to go anywhere. Not afraid to work or face responsibility. Can handle help efficiently.

B-8

Education—Chemistry and Dyeing Department, Philadelphia Textile School.

Experience—Eleven years experience as chemist and boss dyer on the following: woolen, worsted and cotton yarn; woolen, worsted and union piece dyes on both ladies' and men's wear; wool, cotton, shoddy and mohair raw stock. Age 33, married, will go anywhere. References.

B-9

Experience—Hosiery dyer with fifteen years' experience on high grade silk hosiery; familiar with all types of machines. Age 43, married. Will go anywhere.

B-12

Education—2 years days at N. Y. U. and 3 years nights studying chemical engineering.

Experience—1½ years asst. colorist, 5½ years colorist. Experienced on vats, commercial and fast colors on cotton and cotton-rayon mixtures. References; age 29; married.

B-13

Experience—Large experience as an assistant colorist chemist in silk printing, dyeing and finishing; also on cotton and wool dyeing. References.

B-14

Education—Rhode Island School of Design.

Experience—Familiar with all classes of wool dyeing. Seven years with large carpet mill as dyer and processor of washed oriental rugs. Will go anywhere, married, 37 years old. References.

B-15

Education—B.T.C., Lowell Textile Institute, 1934.

Experience—Experience in dye house running washers, dye kettles and as a dye weighter.

B-17

Education—Lowell Textile Institute (Chemistry and Dyeing Course) 1916; extension courses at Brown University.

Experience—6 months dyeing wool at finishing company; 2½ years research work on bleaching, dyeing and finishing at dye works; inspector of textile equipment, U. S. Ordnance Dept., during war; 15 years as superintendent of dyeing at finishing company, including all types of colors on cotton piece goods and some rayon and celanese; handled chemical work at last named plant for many years as well as dyeing. Age 40, married, prefers East. References.

CALENDAR OF COMING EVENTS

Meeting, New York Section, Chemists' Club, New York City, October 25, 1935.

* * *

Meeting, Piedmont Section, Hotel Charlotte, Charlotte, N. C., November 9, 1935.

* * *

Annual Meeting, December 6 and 7, Chattanooga, Tenn.

MOCCASIN BEND (TENNESSEE RIVER) FROM LOOKOUT MOUNTAIN. CHATTANOOGA IN BACKGROUND

ANNUAL MEETING AND CONVENTION

CHATTANOOGA, the scene of the coming meeting of the A.A.T.C.C. on December 6th and 7th, will be of considerable interest to all who are planning to attend. Located in the extreme southeastern portion of scenic East Tennessee, near the border lines of Alabama and Georgia, Chattanooga enjoys a highly strategic geographical position in relation to the entire South as well as the full benefits of a superb setting amid the ridges and mountains of a region as widely noted for its grandeur and historic associations as for richness in natural resources.

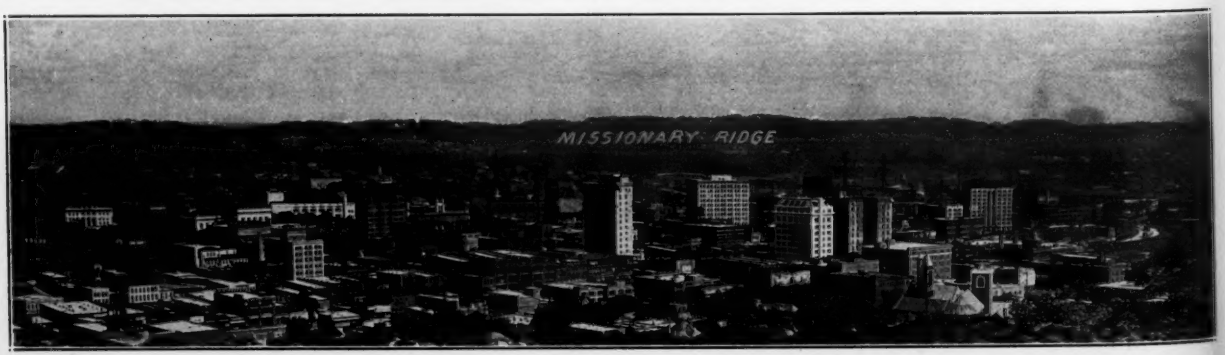
Situated in a fertile valley, through which the mighty Tennessee River winds, and bounded by famous Lookout Mountain, Signal Mountain, Raccoon Mountain, Missionary Ridge and other rises of the Cumberlands, Chattanooga is endowed with mountain and valley scenery said to be of unequalled magnificence. In addition each natural scene of beauty is enhanced by historic association with either the Civil War days or the days when the Cherokees paid tribute to the natural richness and beauty of Chattanooga's surroundings by selecting its valleys and mountains as a domain.

In addition to the scenic and historic interests of Chattanooga, it has also forged ahead to a clearly defined leadership among Southern cities in commercial and industrial activities. Today Chattanooga is said to be known in domestic and export fields as one of the country's foremost business and manufacturing centers.

Accustomed to entertaining a constant flow of visitors, Chattanooga is an experienced and enthusiastic hostess, always exerting every effort to make each guest's stay pleasant and profitable. In and about the city are fine motor roads. Train schedules are conveniently timed. The Chamber of Commerce and other civic organizations as well as the citizens of Chattanooga are always eager to give everyone information and to assist everyone to make the most of his visit.

DECEMBER 6th & 7th CHATTANOOGA, TENN.

SKYLINE VIEW OF CHATTANOOGA WITH MISSIONARY RIDGE IN THE DISTANCE



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REPORTER

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● COMMUNICATION

Re The Valuation of the Fastness to Light

"Fastness" is a term inseparably connected with textile finishing, and this applies more especially to "fastness to light". The very quick progress made by the color making and textile industries rendered it necessary, in the interest both of consumer and manufacturer, that the dyestuffs placed upon the market were graded according to a fastness to light expressed in figures. About 20 years ago the first trials were made to standardize the fastness to light. At that time the Fastness Committee of the Chemical and Texile Groups of the Association of German Chemists published the first scales intended to standardize the fastness to light of dyeings on wool and cotton, which were, later on, followed by such on other textile fibers, as silk, rayon, and acetate silk. There was no relation, however, of the wool types to the cotton or silk types with regard to fastness to light and, consequently, there was no possibility to compare the fastness-to-light figures on the various kinds of fiber as between themselves. The figures obtained by means of these scales give, therefore, only limited information regarding the fastness to light of a certain dyestuff in *one* certain depth of shade on *one* certain kind of fiber, without the effect of the fiber or the behaviour of the dyestuff in another depth of shade than that standardized being taken into account in the exposure.

Appreciating these difficulties, endeavors were made recently not only in Germany but also in other countries, to work out a more exact method of standardizing. It was only natural to adjust the available scales for the individual fibers upon each other in such a way that they gave figures that could be compared to each other. However, it was soon recognized that the process of fading, which takes place when dyeings are exposed to light, depends upon a variety of factors, more especially the humidity of air, so that dyeings on the individual fibers, according to the exposure conditions, gave more or less fluctuating results in the valuation of the fastness to light. Another way had therefore to be found.

The degree of fading of a dyeing, apart from air moisture, is dependent upon the quantity of light that operates upon it. There are quite a number of physical methods for determining the quantity of light; the practical value of those methods is very differently estimated at present.

Trials were therefore carried out to find an independent valuation, like the former methods again on a color basis, applicable to dyeings on all kinds of fiber.

After complicated and exhaustive trials covering the influence of air moisture, the fiber, the temperature, etc., on the exposure test, a range of 72, specially selected, dyeings on various fibers (cotton, wool, silk, etc.) were exposed in 20 places from the 65th northern to the 38th southern degree of latitude, from about sea level to a height of 3694 meters. The result of these tests, which were carried out under entirely different climatic conditions, confirmed what had been ascertained by previous trials, viz, that *wool* dyeings show a much greater uniformity in the degree of fading under varying conditions than dyeings on other fibers, more especially cotton.

For this reason the use of 8 *type dyeings on wool* was chosen for the future scale (see publication of the German Fastness Committee, 6th edition, of Processes, Standards and Types, 1932).

This scale of types makes it possible to establish at any time the fastness to light of dyeings, because

(1) the scale can be reproduced without difficulty,
(2) it is independent upon climatic conditions, and
(3) it is possible to compare the fastness to light of dyeings of any depth and shade on any kind of material.

By establishing this scale it is possible to standardize any *dyeing* in future.

The new light-fastness scale is applied by fixing the fastness to light of each *dyestuff* by 3 figures. These figures refer to three different depths of shade which, as a rule, are in the proportion of 1-3 : 1 : 2 to each other. (In certain cases exceptions will be necessary from these proportions, in all cases, however, the depth 1 will be stated.) The dyeings prepared in depth 1 are chosen in such a way that they agree with each other in strength in all shades, and on all materials, with the exception of Navy Blue and Black, the figures for which are given in fuller shades. The figures for fastness to light for depth 1 are rendered conspicuous in our publications by heavy print and *are comparable between them.* To facilitate the production of dyeings in this depth of shade, so-called auxiliary types have been prepared in the most important shades on the various kinds of fiber, which are used only for this purpose, but not for establishing the fastness to light.

(Continued on page 606)

Dyeing Jute Yarn *and* Jute and Cotton Piece Goods*

Suitable Basic, Acid and Substantive Colors: Methods of Producing Solid Shades on Union Goods

By JAMES R. McILVEEN

THE first part of this article will deal briefly with the coloring of jute yarn with basic, acid and substantive dyes: we shall then consider the processing of jute and cotton unions. While a good deal of jute yarn is dyed with acid colors, basic dyes are probably used more than either acid or substantives for processing jute, especially where the stock is for use in cheaper grade domestic furnishings, etc. The affinity of jute for most basic dyes is good, in fact, the fiber attracts basic dyestuff so strongly that penetration and levelness prove unsatisfactory unless precautions to slow down the absorption rate of the dye are taken during processing.

Let us first consider the application of basic dyes to jute. The following are amongst the most useful colors for this work: Auramine, Acridine Yellow, Chrysoidine, Bismark Brown, Methyl Violet, Methylene Blue, Magenta, Saffranine, Malachite Green, and mixtures of certain aforementioned dyestuffs which are subsequently sold to the consumer as Basic or Jute Black.

When jute is to be colored with basic dyes, the requisite amount of dyestuff is dissolved in hot water containing a generous amount of acetic acid and after sieving twice, the solution is poured into the cold dyebath. The extra labor entailed in sieving the dye solution twice is always a worthwhile proposition when processing medium and pale colors on jute, since no trouble is encountered through tarry specks of undissolved dye adhering to the yarn later to cause dark or off-tone bloches during processing in the hot bath.

After the dyestuff solution has been put in the bath, an addition of 5 to 10 per cent of alum on the weight of yarn to be processed is made. Where pulverized alum is used, the requisite amount of this may be strewn in the dry condition into the bath; in the case of lump alum, it is better to dissolve the crystals in hot water before adding to the bath, especially if pale hues are to be processed. With dark colors and black, the lump alum can be used just as it is, but it is preferable to break up the larger chunks.

When the bath has been made ready, the wet-out yarn is entered into the cold dyebath, the liquor being circulated for ten or twenty minutes before heating is begun. If pale colors are being processed, the bath may be raised to the boil during one hour. On the other hand, this period can be cut down to half when dyeing black and other heavy shades. When the bath has boiled half an hour, exhaustion will usually be sufficiently complete to permit of shade sampling to be done. Nevertheless, it is wise to allow boiling to continue for rather longer than half an hour if heavy shades are on hand, since in some instances one or other of the dyes in a combination shade will have a slower rate of exhaustion than the rest and may upset salting calculations.

It is usually recommended by color makers to process Auramine below the boil in order to prevent the decomposition of the dyestuff, since in this event the shade is considerably duller. This procedure serves well enough with easily-penetrated material, but if the jute stock consists of thick yarn, penetration is unsatisfactory if the bath is not well boiled for half an hour or so. The advisability of processing at the boil with Auramine in the bath depends upon the hue to be produced. For instance, if a composite brown shade containing Auramine as the sole yellow component is on hand, the dulling effect ensuing by processing at the boil will hardly be so noticeable as it would if the self shade of Auramine in maximum purity had to be produced. Similarly, one might feasibly boil the bath when processing an olive green, whereas such treatment would in the case of a brighter green prevent the attainment of maximum shade brilliancy. On account of the liability of Auramine to decompose in a boiling bath, some plants use Acridine Yellow for self shades instead. Acridine Yellow yields bright hues on half and full bleach jute, but the shade is somewhat less pure and rather redder in full tones than the self shade of Auramine.

Acetic acid may be used in place of alum for processing basic dyes, the amount of acid used being up to about 5 per cent. Shades processed with acetic acid often turn out somewhat thinner and paler than those produced with similar amounts of dyestuffs and alum in the bath, but the dyeings done with acetic acid show better fastness to rubbing in the majority of cases. Amounts of acetic acid up to 5 per cent on the stock prove suitable for processing heavy shades; with paler hues, the use of 1 to 3 per cent

*The Dyer & Textile Printer.

is ample for securing uniform colors. With the object of improving the fastness to washing of shades produced with acetic acid, it is occasionally the practice to make an addition of one-half of one per cent alum to the exhausted bath; since this procedure sometimes has the effect of causing the shade to become fuller, the alum addition can only be made where there exists sufficient margin between the standard shade and the present color of the batch to permit of its application. Furthermore, if the shade on hand is a compound one, the addition of alum may disturb equilibrium in exhaustion rates of component dyes hitherto unabsorbed while processing with acetic acid alone, and also the possible result of an unforeseen change in color and the risk of stripping and redyeing.

A good many basic colors do not penetrate or "heart" thick jute yarn very well, especially in combination hues processed with ill-chosen members of the class. In bad cases, the processed yarn upon untwisting a sample, will show a different tone in the interior from the outer paths. In particular, Methyl Violet and Bismark Brown are examples of basic dyes which fail to penetrate thick stock under ordinary processing conditions; moreover, the latter dyestuff does not blend well with other dyes and is rather apt to produce polychroic or "skittery" hues.

In the production of browns, greys, fawns and similar mode shades on jute stock, combinations of Magenta, Malachite Green and Chrysoidine produce level colors free from polychroism when processed with ordinary care. This combination of dyes in suitable proportions will also serve for black; in fact, it is probable that some of the commercial "Jute Black" sold in the compounded condition consists of mixtures of the three dyes mentioned. Some of the Basic Browns are also prepared from different proportions of the same dyes; these mixtures have been evolved to meet the requirements of plants who have found difficulty in processing solid brown hues by use of Bismark Brown or other dyes compounded by their own staff.

Turning now to the consideration of acid colors for use on jute stock, it should be pointed out that this class of dyestuff offers certain advantages over basic colors inasmuch as stock processed with acid colors acquires shades possessed of considerably better fastness to light. Moreover, the stock is better penetrated by acid dyes and difficulties from polychroism are seldom encountered. Nevertheless, this trouble is liable to crop up as a consequence of careless salting of heavy amounts of dyestuff in the hot bath, especially in combination shades. The number of acid colors for use on jute stock is not extensive since the majority of the class do not exhaust well on this fiber. Amongst the popular dyes for jute may be mentioned Indian Yellow, Acid Scarlet, Rocelline and Fast Red A types, Soluble Blue, Acid Green, Orange II, Orange IV, Fast Acid Violet of the 4R class, and Acid Base Black. These dyes are applied to jute in a boiling bath with 10 per cent Glauber's salt and 5 to 10 per cent alum. Instead of alum, 1 to 2 per cent formic acid can be used, but in this event, exhaustion is not so good upon the whole. Processing is done for one hour at the boil, after which the stock may be allowed to feed in the cooling liquor if the shade is not full enough. Processing at the boil has a tendency to retard absorption of the more soluble dyes.

One fault of jute stock processed in full colors with acid dyes consists in the liability of the dyeings to bleed heavily upon rinsing the material after coloring. To circumvent this, the stock can be wrung or centrifuged without rinsing when taken out of the dyeing apparatus. Curiously enough, once the stock has been dried, the color does not bleed to the same extent as takes place with material washed straight away after coloring. Since acid colors have considerably less affinity for jute than basic dyes, processing can be begun at higher temperatures, and with self colors in full shades, the stock may be entered into the boiling bath where the levelling properties of the chosen dyestuff are suitable for such a procedure. Acid Orange such as, for instance, Orange II, Indian Yellow and Fast Acid Violet 4R are sufficiently levelling as to permit of speeding up processing in the manner mentioned.

Considering now the processing of jute with substantive dyes—one sterling advantage accruing from the use of this class of dye consists in the superiority towards washing and rubbing of jute stock processed with substantives over material colored with basic and acid dyes. Furthermore, some of the substantive dyes penetrate thick jute yarn much better than any of the basic and acid colors. The following direct colors may be used for dyeing jute, and are known by the writer to give good results: Chrysophenine, Direct Brown G, Direct Brown R, Direct Green B, Diphenyl Fast Orange WS, Chlorazol Bordeaux 6BS, Direct Blacks E, R and BH, Direct Fast Black B, Direct Sky Blue FF, Diphenyl Deep Blue, and Direct Yellow R types. This last dyestuff does not yield so good a color value as Chrysophenine, but it is level dyeing and penetrates well. Unless standing baths are kept with this dyestuff, the use of the product is not an economical proposition.

Jute absorbs substantive dyestuff best when dyeing is conducted at temperatures between 80 and 90 deg. C. Processing at the boil retards absorption of some substantives, notably Direct Black E, hence when black is to be processed by use of this dyestuff, the best value from the color is obtained by dyeing below the boil. At the same time, it is wise to boil thick stock for a quarter of an hour at the commencement of dyeing in order to produce a well-penetrated black. In the production of medium and pale colors with direct dyes, dyeing may be done throughout at the boil.

The assistants used in the dyebath consist of soda ash, Glauber's salt and common salt. The latter should only be used for dark colors. Two per cent of soda ash on the weight of the stock is an average amount to employ. The proportion of Glauber's salt to process medium and pale colors may be from 5 to 10 per cent, according to the depth of the particular shade. For full shades and blacks, 5 to 10 per cent of common salt can be used in place of

Glauber's salt in order to obtain good exhaustion from the bath.

We will now consider processes for coloring jute and cotton unions. As the affinity of jute for substantive and basic dyestuffs exceeds that shown by cotton, it usually proves a difficult task to obtain equal depth of shade on both these fibers, especially if the jute is not bleached. In the production of pale hues on jute and cotton unions, it is wise to full bleach the jute before the goods are woven and to use unbleached cotton along with the other fiber. In this way, the joint color of the background is rendered more uniform, since even fully-bleached jute seldom exhibits the stark whiteness of well-bleached cotton fiber. It is quite true that the bleaching of jute can be carried to such an extreme that it becomes almost as devoid of natural coloring as bleached cotton, but the severe processing necessary for obtaining a result like this degrades the strength of the fiber extremely and also causes it to shrink, hence severe treatment of jute goods in the bleach croft has to be strictly avoided.

Substantive dyes applied in a bath made alkaline with soda ash are the best dyes to use for jute and cotton unions. An addition of 10 to 20 per cent of Glauber's salt should be used for medium and light hues, while 5 to 10 per cent of common salt is a suitable amount to use for black and other heavy shades. From 2 to 3 per cent of soda ash is employed in the bath as a restrainer for the substantive dyestuff and as an aid towards securing penetration and levelness. Processing in a boiling bath must be avoided or the cotton will not be well covered, since substantive dyes boil more easily off cotton than jute fiber. It is permissible to allow a short treatment at the boil for levelling and penetration upon first entering the goods into the dyebath. The best temperature for obtaining solidity in the color of each fiber is about 80 deg. C., but processing at a temperature like this is not conducive towards good penetration of hard-spun jute.

All the direct dyestuffs mentioned as being suitable for the dyeing of jute stock can be used for processing jute and cotton union. With the exception of Direct Yellow R, the dyes enumerated color jute more heavily than cotton when applied at the boil or below this temperature. However, Direct Yellow seems to be taken up by the cotton to a greater extent than by jute when processing is being done at 80 deg. C., and this trait makes the dyestuff a useful shading color on occasion.

Heavy qualities of jute cotton unions are processed in kettles with winches, the goods being run in rope form. Lighter sorts of this fabric can be jig-dyed. Where a shade is unobtainable with substantive dyes in the union bath, it becomes necessary to top up the batch to shade in a fresh bath with either acid or basic dyes. This operation can either be performed in the winch kettle, the jig, or a two-bowl padding mangle. Topping with basic dyes is done in a warm bath containing 1 per cent or more of acetic acid. Processing must be started in the cold bath to ensure level colors. The topping dyes color both jute and cotton fibers in this process, hence topping with basics is of little use in correcting differences in hue between the two fibers where this divergence is considerable, as happens sometimes through faulty processing or from the use of unsuitable substantive dyes.

A certain amount of shading of the jute can be done by topping the unions with acid dyestuff in a warm alum bath, although the cotton is somewhat stained also. Nevertheless, the jute fiber usually absorbs more of the acid dyestuff than the cotton does, and it frequently becomes possible to color the jute to match a standard pattern by adopting the procedure mentioned. This method of topping is a useful one where it is desired that the shade of the jute should be somewhat different in tone from that of the cotton in order to bring into greater prominence the lustrous quality of good grades of jute. Formic acid may be used instead of alum when topping the unions in the warm bath. In this event, little staining of the cotton by the acid color takes place.

At the present time, considerable quantities of a heavy jute and cotton union are being used for waistcoat backings, particularly where it is known that hard manual labor has to be done. Thus we find some of the railway companies are contracting for such a cloth to be used on certain of their servants' uniforms. For this particular purpose, the union is usually dyed a sulfur black, lightly stiffened with sago starch and given a high beetled finish. The pieces are run on the beetles wet, and beetling continuously carried out for about ten days to a fortnight!

Power and Heat—

(Continued from page 591)

When the pressure rises above that normally required, the surplus is released and led into a heat accumulator and stored against future requirements, thus saving time and also materially reducing the "peak" demand for steam from the boilers.

Practically the same scheme will overcome the question of the evening load in a dyeworks when the boiling process is finished, and yet a considerable amount of power is required for the hydro-extractors, and the drying machines and general lighting. In this case, all surplus exhaust for the last hour of the day is passed through a surplus valve, and led through an open type of heater, in which the steam and the water are intimately mixed, thus producing heated water, which in well-lagged tanks will be available with very little loss for the first hour or so the next morning. Such an arrangement allows of work being under way more rapidly each day, and reduces the "peak" demand for live steam direct from the boilers.

Technical Notes from Foreign Sources

Azo Dyestuffs (Dis-azo)

German Patent No. 499,071 (*May* 30, 1930)—*I. G. Farben-Ind. A.-G.*—In the process here protected, 1-3-6- or 1-3-7-naphthylamine-disulfonic acid, or the mixture of the two as technically obtained, is diazotized and coupled to alpha-naphthylamine, and this amino-azo dyestuff is diazotized and coupled to an anilide of 2-hydroxy-3-naphthoic acid (e.g., the anilide itself in one example given). As one of the components possesses two sulfonic acid groups, the product is soluble in water, and is salted out. As an acid dyestuff, it dyes wool in bluish-black, fast tones, from an acid bath.

In German Patent No. 85,572, similar dyestuffs involve beta-naphthol as the terminal component. The present products are deeper in tone, and faster to light.

Contribution to the Study of Substantive Dyestuffs

M. Lesbre—TIBA 10, 905 (1932).—A continuation of this paper, a previous part of which has already been commented upon in these columns.

The present section deals with Congo Red and Diamine Red. Four quantitative tables and a graph record the author's results in studying the dyeing powers of these colors; giving, for a given weight of cotton and a given concentration of dyebath, the colorimetric figures for the cotton and for the bath as dyeing progresses, over periods of from 0 to 120 (168,144) hours (and this, for the whole of the color-groups of the spectrum). From his discussion of the meaning of the figures, we quote some very interesting and instructive remarks:—

The relative proportion of the volume of the bath to the weight of the goods has its influence upon the substantivity of the dyeing, independently of the factor of concentration of the dyestuff. In a short bath, the quantity of dyestuff retained by the bath is relatively greater, other things being equal; a fact which can well be explained by another fact, that the attractive forces of the cotton fibers, acting upon an equal volume of bath, are at a maximum in a short bath.

As to the dyeings carried out in dilute baths, we have measured the resistance, to rubbing, of swatches dyed in the same manner. If the swatches dyed with Diamine Blue do not crock to an appreciable degree, yet the swatches dyed with Congo Red do not prove to be of exceptional solidity. The resistance to rubbing of swatches dyed toward the end of the tests were less easily determinable than were those dyed toward the beginning; which shows plainly that the second phase of the dyeing process is one of mechanical entanglement of the dyestuff particles with the fiber-substance, a situation in which the coloring matter goes on and remains by simple adherence, upon the cellulose fibers.

To sum up: in the dyeing of cotton in the cold, without the presence of electrolytes, we have distinguished two cases:—

(a)—That of very dilute solutions; the dyestuff penetrates into the interior of the fiber, owing to the high degree of dispersion of the bath-content; thus producing an internal, irreversible dyeing.

(b)—That of dyeing from concentrated solutions; one can then easily distinguish the quantity of dyestuff fixed substantively (properly understood) from the part of the dyestuff mechanically fixed, which simply lies upon the surface of the fiber, producing thus tones richer, indeed, but less resistant to rubbing.

Altogether, our observations show that it is the degree of dispersion of the baths which govern the substantivity of the cold dyeings of cotton; in such cases, there exists an optimum maximum of colorific particles, corresponding to a good penetration of the cotton fiber; the particles should not be either dispersed to the molecular stage (by too great dilution of the bath); their optimum dimensions doubtless correspond to those of the intermicellular spaces of the cellulose of the fiber.

Bleaching and Causticizing Cotton in the Cold

Dr. Justin-Mueller—TIBA 10, 911 (1932).—In the classical method of bleaching cotton with hypochlorite, the operation of bleaching, properly so called, takes place in the cold; in some establishments where the work is not carried on in a logical manner, the operation is conducted in the heat (lukewarm), but this method is the exception. Generally speaking, bleaching, especially as the term is used to apply to the bleaching of piece goods, always implies, together with chloring, a boiling-out or kiering, with or without pressure. This process of kiering is at least one as important as chloring, and is considered to be an integral part of the process of piece goods bleaching. The whole process, in its general scope, implies kiering, followed by treatment with hypochlorite, i.e., bleaching in part at least in the heat.

If we speak, however, of cold bleaching, it is obvious that we are considering a pre-chloring in the cold, replacing the kiering or boiling-out. Attempts to carry out such a process successfully are as old as the bleaching industry; but the difficulty has always been the impossibility of proper wetting-out of the goods, and so, above all, the lack of "hydrophility," or, as we express it nowadays, a water-fiber system, which is indispensable if the bleached goods are to go on, e.g., to be dyed with indigo.

The author has carried out work upon the subject, which has been described in French Patent No. 592,536, of Jan. 31, 1925, and bears there the peculiar title of "Bleaching and Boiling-Out (possibly, kiering) in the Cold," a title adopted merely to avoid confusion in terms

as technically used. But logically, he adds, the proper title would be "Bleaching and Causticizing in the Cold"; as he adds, causticizing can be carried out by means of a pressure-kier or plain boiler, and, in principle, there is no reason why the process cannot be carried out in the cold also.

The preliminary remarks in the patent discuss the situation thus: there exist already a number of patents concerning bleaching in the cold, but all of the processes which are really carried out entirely in the cold suffer from the grave defect of causing the bleaching agent to act upon goods which have not previously been boiled out or otherwise cleansed. Several of these processes are based upon the use of a wetting-out agent in the bleaching bath itself; agents such as certain hydrocarbons, soluble oils, or soaps. This method of procedure, consisting merely in wetting-out the goods, as a preparation for the bleaching, does not free the goods from any impurities in the fiber, but merely makes it possible for the bleaching-agent to gain access to every part of the dirty, unprepared goods; besides, it requires an excessive amount of the bleaching agent, for the latter must act not only upon the substance of the goods themselves, but also upon the colored impurities attached to the goods. The author has found that vegetable fibers, spun or woven, can be rapidly wet-out and "boiled-off in the cold" by treatment in a cold bath containing soluble oils or soaps, alone or with addition of hydrocarbons, or containing resinates, or particularly, preparations formed by the action of the salts of fatty acids upon resinates. Such compounds as the last form the point of the new method.

Colophony (resin) soaps have been employed for a long time in the (actual) boiling-out of cotton weaves intended for bleaching; but such soaps are either insoluble or difficultly soluble in cold water. The author has found that they form particularly clear and strong solutions in the cold, after reaction with ricinoleates or sulforicinoleates. The results appear to be specific for the derivatives of castor oil, for the author has not found it possible to bring about this solubilization of rosin soaps with any other saponified or sulfonated fats or oils, as far as they are at present known.

The goods to be "boiled-out" are simply treated in the cold in a bath containing suitable amounts of the products mentioned; impregnation takes place very rapidly, and the goods are completely penetrated and cleansed; subsequent washing eliminates the principal impurities (starchy substances, grit, etc.) without any need of hydrolysis (enzymatic treatment), and that more rapidly than with the ordinary kiering process. The author has already drawn attention, in a published note, to the fact that kiering (actual hot boiling-out) really converts the solid material present as contaminant in the weave (natural and added impurities) into starches, and fixes them as such in the fiber, instead of removing them. The use of enzyme preparations to de-starch the goods, often resorted to before kiering, to avoid the last-mentioned difficulty, becomes a simple matter in this case; all that is needed is the "scouring" above mentioned, then a wash, then a treatment in a very weak bath of an enzyme preparation, to remove the very small amounts of starchy material still remaining. But even this slight treatment will generally prove unnecessary, if the washing is carried out vigorously, and repeated once.

The strong point of the process lies in the fact that the fiber of the cotton is not attacked or damaged in the slightest degree; there is absolutely no loss of tensile strength in goods scoured in this new manner.

One example given describes the bleaching of cotton goods by treatment in any suitable continuous-working apparatus (Foulard, jig, etc.) with a bath containing 1 per cent of a 40 per cent preparation of the type mentioned, for a very short time (once or twice through, completely), then washing, and treatment in a hypochlorite bath containing 0.4-0.5 per cent of active chlorine, for about two hours, though the time may be extended, even to leaving the goods in over night. The goods are then rinsed, passed through a weak bisulfite bath (preferred to an acid souring), rinsed, blued and dried. This method gives excellent results for plain goods, but, as it does not hydrophilize the fiber (i.e., does not make it rapidly absorbent to water, as does the caustic treatment inherent in ordinary kiering), the goods are not in suitable condition for later dyeing, or for certain special methods of finishing as white goods.

For such goods, the author has found that a proprietary compound, Igepon T, will both wet-out, cleanse, and give the goods this necessary affinity for aqueous baths, very successfully; and recommends and gives recipes for its use in his process, without its tendering the goods in any degree.

The process is one of method, rather than one involving the use of any definite chemical assistants, and depends upon the recognition of the fact that ordinary kier-boiling is comparatively expensive and troublesome, and also attacks and weakens the goods.

Sulfonic Acids of Leuco-Vat Dyestuffs

German Patent No. 472,925 (*March 7*, 1929)—*I. G. Farben-Ind. A.-G.*—The process here described consists briefly in the reduction of vat dyestuffs, and condensing them, as they exist in the form of alkali salts of the leuco-form in solution, with halogen-alcohols, of the type of ethylene chlorhydrine, preferably in the presence of alkalies, such a reaction being easy to carry out in the heat, even in the presence of much water, comparatively speaking. The products can be dried safely in the air, in the form of a press-cake. Such compounds can be easily reacted further with chlorsulfonic acid or compounds of a similar type, to form sulfuric esters. Such derivatives, however, on being subjected to the action of warm concentrated sulfuric acid, split again into the original dyestuff or its leuco-derivative, among other products. If, however, the chlorsulfonic acid is allowed to act upon the hydroxy-alkyl-leuco-compounds in the absence of water, and in the presence of organic bases of the type of pyri-

dine or dimethylaniline, which will neutralize the HCl set free without themselves entering into undesired reactions with any component present, the resulting compounds possess the character of fairly stable sulfonic acids, and their alkali salts are more or less easily soluble in water. They behave like acid wool dyestuffs, and by treatment of the impregnated fiber with oxidizing agents pass back into the original vat dyestuff, by hydrolysis and oxidation.

Two examples are given, each for wool specially; one dyes a wool a bordeaux-red from an acid bath. This color goes over to a red- or reddish-blue upon oxidation.

Vat Dyestuffs (Chrysazine Series)

German Patent No. 478,280 (*June* 20, 1929)—*British Dyestuffs Corp., Ltd.*—Limited to the reaction of formaldehyde-bisulfite in the heat, in absence of strong mineral acids, with diamino-chrysazine, the product being the N-methyl-omega-sulfonic acid of diamino-chrysazine. (See also G. P. No. 112,115 for the preparation of similar derivatives of certain amino-anthraquinones.) One example is given.

Vat Dyestuffs (Anthraquinone Series)

German Patent No. 475,688 (*April* 30, 1929)—*I. G. Farben-Ind. A.-G.*—German Patent No. 243,750 describes the condensation of 1-halogenated or 1-nitrated anthraquinone-2-carbonic acids and aryl-mercaptans to aryl-thio-1-1-anthraquinone-2-carbonic acids, and the condensation of these, by heating with a dehydrating agent, as sulfuric acid, to thio-xanthones. The present patent extends this method by condensing an anthraquinone substituted in the 2-7-positions by mercaptan groups, with two molecules of a 1-halogeno- or 1-nitro-anthraquinone-2-carbonic acid, and then condensing these compounds internally by heating with a dehydrating agent (sulfuric acid), the OH of each carboxyl splitting out with the 1- and the 8-hydrogens of the middle anthraquinone nucleus, to establish a product consisting of three anthraquinone nuclei fused together in the 1-2-positions by two thioxanthene bridging-groups.

Two examples are given. The products are vatted in warm hydrosulfite, and dye cotton in strong yellow tones.

Rayon and Oxygen Bleaching

H. Russina—Monats. f. Seide u. Kunst-Seide 38, 370 (1933)—The history of bleaching by means of hydrogen peroxide shows a kind of timidity to have prevailed regarding its general usefulness. Its value as a bleaching agent for natural silk, and to some extent for wool, was early recognized, but its application to the problems of vegetable fibers seems to have been little more than occasional or incidental. This sort of timidity or reluctance regarding it prevailed until a series of studies by the experts of the Deutsche Gold- u. Silber-Scheide-Anstalt made known the conditions under which peroxide could be used successfully, in a caustic-alkaline bath, or, what amounts to the same thing, sodium peroxide as the agent. The chief advantage of this method, of course, lay in the fact that the use of caustic alkali in the bath made keir-boiling unnecessary. This point deserves to be emphasized; as against bleaching with chlorine, the presence of caustic alkali causes the peroxide solution to penetrate the goods (using the pack- or loading-system) rapidly and effectively.

One important detail is the fact that silicate of magnesium or calcium must be present in the bath, to assure perfect safety to the cotton fiber. This requisite is usually taken care of by adding water-glass to the bath in suitable amount, this reacting with "the hardness-formers always present" to form the silicate of magnesium or calcium needed, it also softening the water at the same time. (But what of work in districts where the nearest deposits of limestone or magnesite or dolomite are more than mere hundreds of miles away from the water-source—in some of our granite areas, for example?)

Normal hydrogen peroxide is a substance almost completely stable. In aqueous solution, it can be heated, cooled, reheated, many times, without appreciable loss of active oxygen. But, if the solution is made even slightly caustic-alkaline, the peroxide begins to break down at once, the active oxygen being progressively lost as gas. Calcium and magnesium silicates stabilize the peroxide in presence of caustic, and must therefore be present even if the bath is to be used only for the one run.

Raw cotton is practically not bleached by hydrogen peroxide alone, but is perfectly bleached by such a bath as above (caustic alkali and one of the silicates being also present), and this, without any tendering of the fiber. A peroxide bath containing caustic alkali, but no silicate, does not bleach so perfectly, and in most cases there is also tendering of the fiber. The different factors may be summed up thus: the caustic alkali "loosens up" the oxygen of the peroxide in such a manner that it is easily given up to the fiber, etc., in the nascent state (therefore effective for bleaching). The alkali also acts as a solvent agent, removing from the fiber the impurities which have been oxidized, thus making the white a permanent one (compare the mere temporary decolorization brought about by sulphur dioxide, the impurities thus remaining, capable of reoxidation, upon the fiber). If stabilizers (the silicates mentioned) are absent, the peroxide not only gives up active oxygen in the nascent state for the purpose of bleaching, but also gives up more of it as gaseous, ineffective oxygen, which means not only a loss of effective oxygen for the bleaching, but also an attack upon the cellulose, resulting in loss of tensile strength.

A further point brought out is, that the silicates, as stabilizers, can act in that manner only up to a certain degree of alkalinity. If the concentration of caustic alkali is too great, (or, using sodium peroxide, if too much of this agent is added to the bath, without partial neutralization of the alkali thus set free), the bath will lose much of its active oxygen rather rapidly, in the form of

foam. Even if a stabilizer is present, this presence of free oxygen in the bath (for of course, with the evolution of it, the bath will dissolve what it can before or while the foam is forming) will take its toll in attacking the fiber. It is better, therefore, to use two baths, with less sodium peroxide in each, than one bath, with too much peroxide in it. Really, the less sodium peroxide in the bath, the less the alkalinity, the greater the stability, the greater the utilization of the utilizable oxygen, and the less the danger of tendering the fiber.

With the perfect results which are now attained with cotton, it is only natural that attempts should have been made to extend the method to artificial silks. The conditions necessary, however, have proved not to be the same. In what follows, it must be understood that the statements apply to viscose rayon. For cupro-rayon obstinately retains minute amounts of copper compounds (indeed, there is no reason why such compounds should be removed, they are so small in amount), and these catalyze the recomposition of hydrogen peroxide energetically, so that for this fiber the method is useless; and further, apart from the loss of active oxygen as loss, the liberation of it in the gaseous and consequently dissolved state is a source of danger to the fiber—see above in this connection). As to acetate rayon, the fact that caustic alkali is present would of course forbid the use of the method, from the certainty of the danger of saponification, and consequently loss of luster, of the fiber. But this matter is not of serious import, since cupro- and acetate-rayons are usually, by the nature of the process used in their synthesis, of a pure white already, and little need bleaching, except in rare cases.

As to viscose, the raw stock always possesses a yellowish tinge, at least, and this color cannot be permanently removed by bleaching with chlorine. Sometimes it cannot be so removed at all, sometimes it can be removed, but the color returns later. The cause of this color is the presence of finely-divided sulfur from the reactions involved in the spinning of the viscose; and, though finely divided, sulfur is not easily oxidized by hypochlorite. Hydrogen peroxide, however, removes it by oxidation and immediate solution, and the results are permanent.

The process as described works well for cotton, and the fiber is not tendered. The same process works equally well for viscose, and the fiber is tendered. The following points involved are therefore to be carefully considered:—

The presence of free alkali, so useful in cotton bleaching, with the type of impurity to be destroyed, is an advantage. Its presence in a bleaching bath for viscose simply leads to weakening of the fiber. Possibly the type of impurity present in the cotton may have something to do with this difference, but the alkali which is so useful in cotton bleaching, and in the presence of calcium or magnesium silicates is so entirely without effect upon the stability of the peroxide, in the case of viscose simply accelerates the decomposition of the peroxide, and the oxygen set free as such attacks and tenders the fiber. The baths must therefore be less alkaline. From comparative tests and analyses of various baths, the author has found that, if the alkali present is only that produced by hydrolysis of the waterglass added, the bleaching is effective, and there is no loss of tensile strength in the bleached viscose; and that, as actual free caustic is added, the damage to the fiber becomes real and progressively greater; the breaking-strength, both wet and dry, may sink to half or less of what it was when only waterglass was added.

For viscose, then, it is necessary, when using sodium peroxide, to neutralize the alkali set free in the bath, and to employ only that degree of alkalinity which will be afforded by hydrolysis of the waterglass to be added as a stabilizer. To attain sufficient bleaching within a satisfactory time, it may be necessary to increase the amount of peroxide (and not in reference to the goods, but as to percentage value of the bath). This may probably mean that a bath will not be exhausted by a single run; but under the conditions noted (exact neutralization of free alkali, and addition then of waterglass) the bath will be stable, and can be used again, though perhaps with more peroxide added, etc.

● COMMUNICATION

(Continued from page 599)

The fastness to light is standardized by 1 denoting the lowest and 8 the best fastness to light.

The figures will signify in future:

1 = poor
3 = moderate
5 = good
6 = very good
7 = excellent
8 = maximum.

The introduction of the new scale for fastness to light, therefore, not only gives the possibility to state the fastness to light of the dyeings on the kind of fiber, but also permits of the comparison of this fastness on various kinds of fiber, which is of special importance for the production of mixed fabrics showing the same fastness to light on the various composite fibers.

The undersigned firms have agreed to carry through the determination of the fastness to light of these dyestuffs jointly according to the above principles. The change-over to the new light-fastness scale, of course, requires considerable work and time, and the individual firms will only be in a position to put at the disposal of their customers pattern-cards and fastness tables on the basis of the new scales very gradually.

I. G. Farbenindustrie Aktiengesellschaft, Frankfurt a.M.
Gesellschaft fur chemische Industrie in Basel, Basel
J. R. Geigy, A.G., Basel
Chemische Fabrik vorm. Sandoz, Basel.

Launderability—

(Continued from page 594)

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● DU PONT DYES

Three new products have recently been announced by the Dyestuffs Division of E. I. du Pont de Nemours & Co.

Lithosol Fast Orange G Powder—the most recent addition to the du Pont range of lake colors, is said to produce bright, reddish shades of orange. It is stated that it will pass the 24-hour Fade-ometer test for wallpaper light fastness and is also of interest as a fast orange for printing inks. It may be used for out-of-door poster work. It is believed that it will find further use as a shading color to produce medium chrome yellow shades in combination with Lithosol Fast Yellow HV.

Pontachrome Brown HN Concentrated—a recent addition to the line of chrome colors said to yield deep, reddish shades of brown on wool raw stock, yarn, and piece goods. It may be used alone or in combination with other chrome colors for dark browns, tans, yellowish browns and olives. It is particularly recommended by the manufacturers for use on men's suitings and overcoatings.

Ponsol Brown AGG Double Paste—a new vat dye, has recently been added to the du Pont line to provide a fast color to be used as a yellow brown base for current khaki shades. It is said to possess the usual good fastness of the vat type of dye, and, when dyed by the pigment-pad process, it is said not to change its shade on soaping or during the various finishing operations. Ponsol Brown AGG Double Paste, it is stated, is suitable for use in the production of current khaki shades.

(Lithosol, Pontachrome and Ponsol are registered trademarks of E. I. du Pont de Nemours & Co., Inc.)

● SCHER BROTHERS MOVE

Scher Brothers, chemical manufacturers and importers in Paterson, announce that they have moved from 190 16th Ave. to a much larger plant and warehouse located at the corner of 21st Ave. and Railroad Ave. It is stated that the new location will have a railroad siding to facilitate the handling of carload and tank car shipments.

● RADIO ADDRESS

On October 5, Victor H. Berman, president of the Onyx Oil & Chemical Co., gave a 15-minute radio talk over Station WAAT, Jersey City, on the subject "The Chemist's Part in the Textile Industry." Following his speech, five more minutes were devoted to questions and answers. Mr. Berman's speech was delivered for the arm-chair listener, written in a non-technical way in order to convey the story of textiles understandably.

Mr. Berman traced the history of textiles from the Stone Age to our modern civilization. Threaded through the talk, was the progress of the chemist in the fields of bleaching, dyeing, printing and finishing. He took the listener through the various steps from raw product to finished goods. He paid respect to the parts Scheele, Berthollet and Tenant played in the art of bleaching; Perkins in dyestuffs; Mercer in mercerizing; and Chardonnet in Rayons. Mr. Berman's speech, given under the auspices of the Jersey City Kiwanis Club, was received with great interest by the listeners-in, because of its entertaining and instructive nature.

The Removal of Stains from

Rayon Fabrics*

By H. ROCHE

IN dealing with rayon materials much greater care is necessary than with silk or cotton as rayon is much more readily damaged. Since the stains encountered are very diverse in character, it is necessary to have a wide range of reagents. When the cause of the stain is known, the remedy is easily arrived at, but usually there is little to indicate the cause and only experience suggests the most suitable method.

Suitable Reagents

Among the reagents used are the following: Various organic acids such as dilute acetic acid, formic acid, oleic acid, oxalic acid, stearic acid, ammonia, borax, sodium perborate, soda ash, sodium bisulfite, common salt, sodium thiosulfate, sodium phosphate; certain organic solvents, alcohol, benzene, carbon bisulfide, carbontetrachloride, chloroform, ether, paraffin, petroleum, pyridine, tetrachlormethane, di- and trichlorethylene; certain salts of potassium such as potassium iodide, potassium permanganate, potassium cyanide, and other substances of a specific nature, hydrogen peroxide, pine oil, sulfonated oils, etc. Not all of these reagents can be applied to rayon goods. If acetate rayon is present, certain organic solvents such as choloroform and acetone are unsuitable since they would actually dissolve the fiber. Also some substances such as potassium cyanide exert a swelling action and may result in tendering. For these reasons it is very important to have knowledge of the properties of rayons and be able to distinguish between the viscose or cuprammonium on the one hand and acetate on the other.

Oil Stains

Stains of an oily or greasy nature include those due to drying oils and may be caused by paints, lubricating oils, etc. After removal of the oily matter, the stain frequently remains due to dirt which has settled on the fabric before the stain has dried or has been present in the oil or grease. These stains are best removed by means of a solvent. Any dirt or pigment remaining must be removed by the application of an oil such as olive oil which is easily scoured out. Sulfonated oils in general are useful for the removal of insoluble matter.

In the case of bad oil stains, particularly if the oil is black, the stain is best soaked with olive oil and left for a few hours. This is followed by gently rubbing in soap liquor containing ammonia. The black oil dissolves in the olive oil which is then emulsified in the soap liquor and gradually scoured out. It is essential that the olive oil is perfectly pure and contains no mineral oil. This is essential if the goods contain cotton or viscose rayon and acetate rayon. Treatment of cotton or viscose rayon with mineral oil causes these fibers to absorb the special range of dyestuffs used for acetate rayon to a certain degree.

Special Soaps

Tetrachlorethylene is a very useful solvent for oil stains. All greasy matter is removed and much of the insoluble dirt which may be present. It is preferable to use it in conjunction with special types of soap. The ordinary water-soluble soaps are not suitable. Originally, calcium and magnesium soaps were used, but these tend to give rise to specks. Superfatted soaps are also used. The best type is the "benzine soap." To increase the detergent power, magnesium and calcium soaps, ammonia and alcohol may be added. The stain is first treated with the solvent and then allowed to soap in 7%—8% soap solution and finally rinsed with the solvent.

Stains due to paint and varnishes are dissolved out with solvents which do not affect the fiber. The solvents used require very careful selection. As mentioned, certain organic solvents have a disastrous effect on rayon. Tetrachlorethane removes paint effectively, but if acetate rayon is present it is advisable to use amyl acetate. In some cases a mixture of equal parts of carbon tetrachloride, amyl acetate and amyl alcohol are used. With acetate rayon the addition of glacial acetic acid is useful, but this must not exceed 30% of the mixture.

Ink stains consist of coloring matter and an iron-tannin base which turns black on drying. The dyestuffs used have an affinity for all rayons but acetate rayon. From acetate rayon the coloring matter is readily washed out. With the other rayons it may be necessary to use a weak solution of bleach if the goods are white. The iron base is removed by means of oxalic acid. This must be applied with great care. The luster may very easily be dulled and in some cases tendering may arise. Potassium permanganate is useful in some cases. Probably the most

*The Textile Manufacturer.

satisfactory ink-stain remover is aceto-oxalic acid in alcoholic solution. When oxalic acid is used, the material may be treated at 160° F. for 10 mins. in 5% solution. This is followed by thorough washing and it is advisable to rinse in very dilute ammonia and give a final washing. This ensures the complete removal of any residual acid which otherwise would cause tendering on drying. Some inks have a carbon base. Here the best reagent to use is monopol oil or soap.

The base of many food stains is albumen. This also applies to blood stains. Such stains are made soluble by treatment with certain enzymatic substances marketed under various trade names. Tea and coffee stains should, of course, be treated at the earliest opportunity and in the cold. Hot treatments tend to fix the stain. Dilute hydrogen peroxide is very satisfactory.

Chemical Stains

Chemical stains fall into numerous subsections and require individual treatment. Nowadays stains due to accumulator acid are frequent. On dyed goods the stain is generally due to the acid affecting the dye. This may be overcome by neutralizing with alkali. Once the stain has dried, tendering is almost certain to occur and this, of course, cannot be rectified.

Where a stain is due to copper, this can be removed by means of ammonia which will dissolve out the metal. If the stain is of long standing, it may be necessary to use potassium cyanide. This requires particularly careful handling since it is a deadly poison. Furthermore, as pointed out, it may have a bad effect on acetate rayon.

It is quite impossible to remove some kinds of stains. A number of fabrics are dyed with colors which spot readily. On wetting, the color runs, and after drying a circular spot with a dark rim is found. The only remedy then is to strip the material and re-dye. If the fabric has been exposed to bright sunlight it may be found that the properties of the fiber have changed, and even after redyeing the spot may show up. The trouble here is due to chemical action caused by ultra-violet light in the sun's rays. Such chemical action is accelerated by the presence of minute traces of metals such as copper or iron. These metals also accelerate the action of sodium hypochlorite and may cause tendering if present.

Perspiration stains on garments frequently become pronounced after wetting. This is particularly the case with materials such as georgettes, crépe-de-chine and taffetas. The fabric may even be tendered and fall in holes if the fabric is silk. This is apparently due to the alkaline reaction of perspiration. Rayons will be found to be much more resistant and this trouble rarely arises with rayon goods unless the colors used are particularly susceptible.

In most cases stains are more readily removed from rayons, but this advantage is offset by the fact that all rayons require more care in handling and the choice of reagents used.

● QUARTERLY PRICE LIST

The R & H Chemicals Department of E. I. du Pont de Nemours & Co., Inc., has recently issued its quarterly price list for October, 1935. Among the items of current interest mentioned in this booklet are new colors for porcelain enamels, solvents for dry cleaning, three sources of active oxygen (bleaching and oxidation) and the value of mercury in zinc plating. Copies of this price list are available upon request.

● SOCIETY OF RHEOLOGY

At a meeting of the Society of Rheology held in the Bell Telephone Laboratories in New York on October 11th and 12th, Irving J. Saxl, director of research and development of the Waypoyset Manufacturing Co. of Pawtucket, R. I., presented two papers. Dr. Saxl's first paper concerned itself with an apparatus in which a chainweight loading device is used for measuring the jelling properties of different types of gelatines. His second paper was a report of research work in which, for the first time, electronic methods were used for investigating the surface properties of gelatines.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF MARCH 3, 1933, OF AMERICAN DYESTUFF REPORTER published bi-weekly at New York, N. Y., for October 1, 1935.

State of New York, County of New York, s.s.:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Alfred P. Howes, who, having been duly sworn according to law, deposes and says that he is the Publisher of the AMERICAN DYESTUFF REPORTER, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of—— Post office address——
Publisher—Alfred P. Howes, 440 4th Ave., New York, N. Y.
Editor—Prof. Louis A. Olney, Lowell, Mass.
Managing Editor—Norman A. Johnson, 440 Fourth Ave., New York, N. Y.
Business Manager—None.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)
Owner: Howes Publishing Company, Inc., 440 Fourth Ave., New York, N. Y.
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3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

ALFRED P. HOWES, Publisher

Sworn to and subscribed before me this 1st day of October, 1935.
(SEAL) CAROLINE ESSENBREIS
Notary Public, Kings County Clerk's No. 165, Register's No. 7060. N. Y. Co. Clk. No. 145, Reg. No. 7E89.
(My commission expires March 30th, 1937.)

OPEN FORUM

Rules under which this department of the REPORTER is conducted are as follows:

1. Anyone who has a technical problem on which he would like advice may submit it to the Reporter and it will be published in the first available issue.

2. Any reader who feels that he has a solution of the problem may forward his reply to us and if we feel that the reply is suitable it will be published in a succeeding issue.

3. For each such reply published the Reporter will pay a minimum of $2.

4. In case there is more than one answer to the same question, the one covering the subject in the most complete and authentic manner will be published, or if two answers are sufficiently different both will be published. If two answers are considered equally good, the one first received will be given priority.

5. The Reporter will assume no responsibility whatsoever for the accuracy of the answers submitted—it is simply offering a vehicle for the public expression of its readers' opinions.

6. Both the questioner and answerer must send in his complete name and address. When requested we will publish only the initials or other identifying insignia.

New Question

31—Occasionally we experience difficulty with worsted and zephyr knitting yarns, in the dyeing of colors such as dark browns and similar shades. It seems that some of the skeins come up in an entirely different shade than others.

Upon checking after dyeing, we find that the darker skeins still contain oil, and after rescouring the dyed yarn, we manage to get a uniform shade. Our method of scouring is as follows:

In a 500-pound Klauder-Weldon dyeing machine, we use about 25 pounds of olive oil soap dissolved. (Weight of soap before dissolved.) Forty pounds of soda ash light 58 per cent, 10 pounds of ammonia, temperature from 110° to 120° F. Rinsing in 120° to 130° F.

This may all be due, of course, to the fact that yarn is steam-conditioned at the mill before it comes to us, and the oil becomes so set that it does not wash out freely.

Perhaps some of your readers can suggest a scouring formula different to that we are using, which will result in more uniform dyeings. Perhaps they may also be able to explain why such a variation occurs.—**D. Y. B.**

Unanswered Questions

29—Is there any known method for stripping sulfur black dyed cotton, or sulfur dyed cotton of other colors in the presence of wool without injuring the wool? The fabric particularly in mind is a sulfur dyed cotton warp with a worsted filling.—**P. B. M.**

30—Will you give me an opinion on the maximum safe temperature for drying of viscose and acetate rayon fibers and fabrics?—**R. C. B.**

27—Is there any satisfactory method for detecting the presence of sulfur black on a dark blue dyed fabric when a small amount of sulfur black has been added to the sulfur blue to deepen the shade?—**P. B. M.**

28.—I am in need of some information in regard to the dyeing of cotton ducks with vat dyes.

The method I am using is the regular pigment pad method, reduction being carried out subsequently in jigs.

In padding 8 oz. and 10 oz. army ducks what density top and bottom padder rolls would be best adapted? Our pad rolls at present contemplated are bottom, 20 plastometer, top 70 plastometer. We have found that equal density rolls give a shading from face to face. The face next to bottom roll being much darker under this condition.

Should this fabric pass under an immersion roll in the pad box before entering the nip, or, will the method use on light weight goods, passing the cloth directly into the nip having the bottom padder roll partially immersed in the pad box and a spray pipe on the top surface to feed the dye liquor, be best adapted to this type of fabric?

Information in regard to the above will be highly appreciated.—**A. M. L.**

CLASSIFIED

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

POSITION WANTED—I have spent many years as superintendent of woolen mills and have established a reputation for administrative ability, integrity and conscientiousness. I am available immediately as superintendent or as assistant to owner to relieve him of many responsibilities connected with plant production. I am willing to demonstrate my ability to allow it to determine my salary. Write Box No. 869, American Dyestuff Reporter, 440 Fourth Ave., New York, N. Y.